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TAKE-ALL AND SIMILAR DISEASES OF WHEAT AND HOW TO CONTROL THEM.*

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The "root-rotting" diseases of wheat known in this State as "Take-all" and "Foot-rot," and which are caused by the fungi known scientifically as *Ophiobolus graminis* and *Helminthosporium sativum*, respectively, have of recent years become the most serious parasitic diseases in wheat crops in this State.

The main reasons for this state of affairs are as follow:—Firstly, there is unfortunately no easy way known of preventing these diseases, as, for example, by the "dry pickling" of the seed with copper carbonate before sowing, as has been found very effective for the control of "bunt" or "covered smut." Secondly, resistant varieties with which to combat them are unknown. This is very different to the situation which exists in the case of "flag smut" where such varieties as "Geeralying," "Nabawa," "Baroota Wonder," "Bencubbin," "Carrabin," "S.H.J." etc. (see Leaflet No. 326, or this Journal pp. 214-17, June, 1931) can be used to follow a heavily-infected crop in this State with every certainty of the new crop being almost, if not entirely, free from the "flag smut" disease. Moreover, thirdly, the three-year rotation system, fallow, wheat, pasture, which is a firmly-established practice in many parts of the wheat belt, *tends to increase these diseases in succeeding wheat crops*, rather than to suppress them, for reasons which will become more obvious later on. Finally, there is a disinclination on the part of many farmers to take these diseases seriously enough in the early stages, with a consequent failure on their part to employ systematic methods of control. This causes a very rapid increase in the size of the areas affected by the fungi, in seasons favourable to their spread.

"Root-rotting" diseases of wheat, due to various fungi, are not in any way peculiar to Western Australia. They occur to a greater or less extent in all the Australian States, and in many other wheat-growing countries, on farms where proper cultural methods are not taken to keep them in subjection.

Microscopic examination in a scientific laboratory is necessary to distinguish properly between the various fungi responsible for "root-rotting" troubles of wheat in this State, but, fortunately, from a practical point of view they may be considered the same, as the control measures, to all intents and purposes, are identical.

* This article represents the subject matter of a lecture given before the Merredin Agricultural Society by the writer on Saturday, 6th February, 1931.

"TAKE-ALL."

"Take-all," due to the fungus *Ophiobolus graminis*, in addition to affecting wheat in patches, which may be more or less circular in outline, also attacks wheat in strips, or even individual plants scattered irregularly through the crop. It causes a very decided, and often shiny, black discolouration of "stocking" at the base of infected stems for up to an inch or more (and occasionally up to three inches) above the point of origin of the main root system. This discolouration can usually be detected, on close scrutiny, by examining the bases of affected plants just as they are when pulled up from the soil, but the characteristic, more or less shiny, stove-polish-like appearance is best seen by carefully pulling the leaf-sheaths backwards and down so as to reveal the actual stem itself.

Fig. 1.—Showing root-rotting and blackening of the bases of stems and leaves of wheat plants attacked by "Take-all."

(*Photo. by Author.*)

Sometimes, and especially on infected stubble in the autumn of the year following infection, little black spine-like objects will be seen poking through the bases of the leaf-sheaths surrounding the lower portion of the stem. These are the beaks on the seed-cases of the fungi, which are formed on the inside of the leaf-sheaths and project out through the leaf tissue into the open air, so that they may the more readily eject their fungus-seeds (*spores*) when the time comes for the infection of another lot of wheat or other susceptible plants. (See Fig. 2.)

In the case of "Take-all," each seed-case (*perithecium*) contains within it large numbers of fungus-seed structures (*spores*), grouped in bundles of eight in thin sheaths called *asci*. (See Fig. 2.) When mature, and the *perithecia* are moistened under suitable conditions, the *asci* with their contained *spores* are forced out into the open. The *asci* then burst and set the *spores* in the bundles free. On germination the *spores* may attack any wheat, barley, rye, barley-grass, or other susceptible plants in the neighbourhood, and so continue the disease. In the absence of any suitable host, however, they soon die. So far as is known, all our wheat varieties are equally subject to "Take-all," but specific information on the point is unavailable. Oats, under normal, good-growing conditions, are, in most districts, highly resistant to this disease.

"Take-all" may be found on all types of soil. It is most prevalent during warm, moist springs, on old land sown down to wheat year after year. It is especially common also in this State in wet, poorly-drained places, and after a field

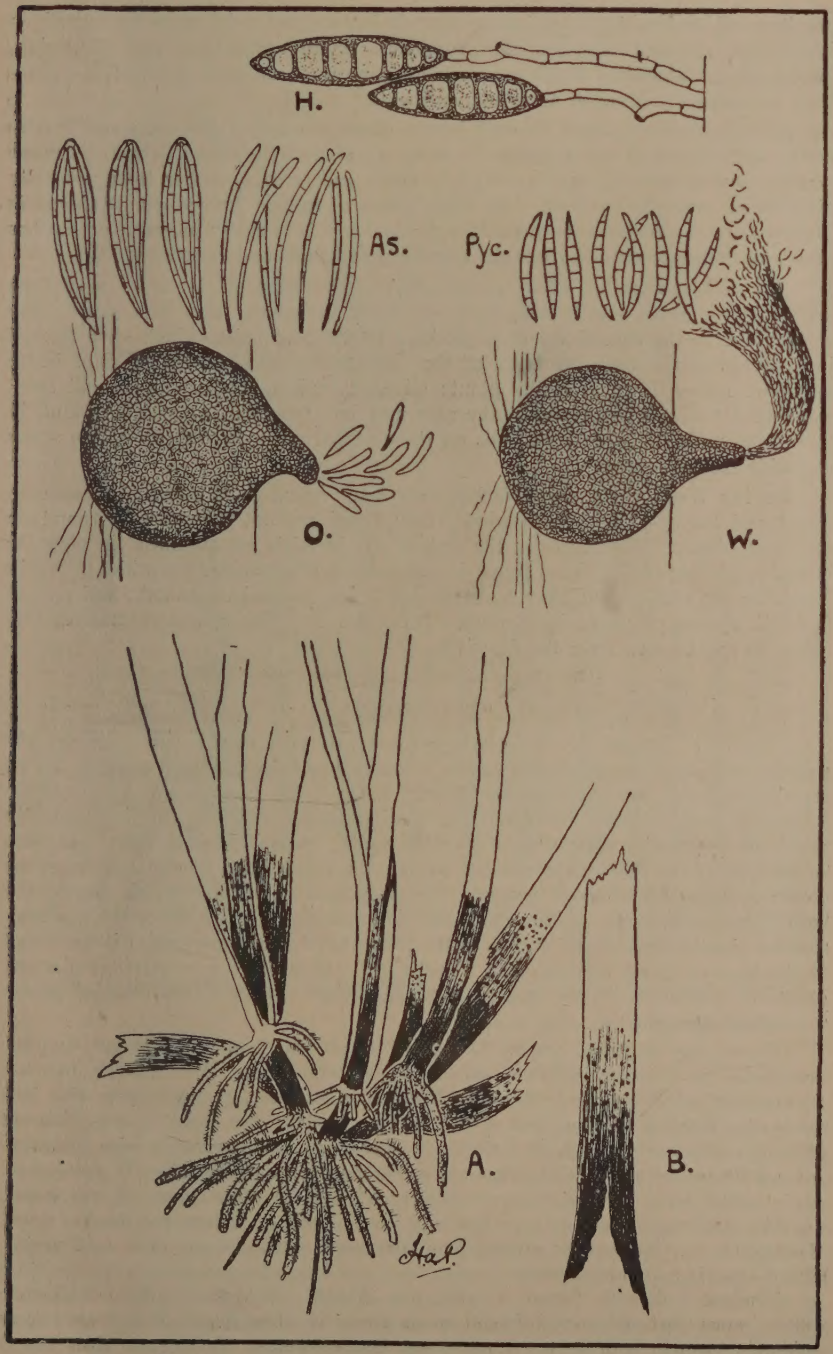

Fig. 2.—A. Wheat plant showing blackening at base of stems and inside the leaf bases due to the "Take-all" fungus *Ophiobolus graminis*. B. Inner surface of leaf-base showing blackening and the fruiting bodies of *Ophiobolus graminis*. O. Fruiting case (*perithecium*) of *Ophiobolus graminis*, with escaping *asci*. W. Fruiting case (*pycnidium*) of *Wojnowicia graminis*. Pyc. Spores of *Wojnowicia graminis*. As. *Asci* and *Ascospores* of *O. graminis*. H. Spores of *Helminthosporium sativum*. All drawings except A and B very much magnified.

has been allowed to grow up into grass. It is rare and need never be feared on intelligently farmed, well-drained properties, where early and clean fallowing, "wet sowing," abundant fertilising, shallow planting, and crop rotation are practised as routine matters of farm management.

Sometimes the blackish or dark-brown discolouration of the stem and insides of the leaf-sheaths is not so extensive as in the case of the true "Take-all" fungus (*Ophiobolus graminis*), and is found in spots and streaks, rather than generally distributed over the surface. In such cases a fungus known as *Wojnowicia graminis* may be found to be present, but whether this is really parasitic or not has been questioned recently by certain workers in Canada and elsewhere.

The root systems of wheat plants affected by either of the above organisms are always more or less rotted, brown or black in colour, and frequently very woolly, due to the excessively close packing of the root hairs, which have formed in great quantities near the butts of the roots to try and absorb sufficient water and food materials to keep the plants alive. "Fruiting bodies" or fungal seed-cases (*perithecia* or *pycnidia*, as the case may be) (see Fig. 2) may be found in both cases under suitable conditions on the diseased roots, as well as on the stems or inside the leaf-sheaths.

So far *Wojnowicia graminis* has only been found in Western Australia on wheat and barley-grass. With wheat, both fungi are not infrequently found on the same plants. The spores in the case of *Wojnowicia* are produced in globular bodies much resembling those found in the case of *Ophiobolus*, but which differ in that they are smaller and may be somewhat hairy, instead of smooth, and do not have the spores produced in bundles. (See Fig. 2.) The spores themselves also differ, as can be seen from the drawings.

"FOOT-ROT."

"Foot-rot" (caused by *Helminthosporium sativum*) may be identified by the presence of one or more characteristic, more or less isolated, light or dark brown streaks or spots near the bases of affected stalks. The base of the stem is often somewhat grey in colour, in addition to bearing the brown spots, and it frequently snaps off very easily from the butts of the roots. A musty odour may also often be detected at the base of the affected stems. The discoloured portions of the stems do not usually extend above ground. The very dark "stocking" which sheaths the base of the stem in the case of "Take-all" is quite absent with "Foot-rot." Sometimes a pinkish discolouration, due to the presence of *Fusarium spp.*, will be found at the base of stems affected with "Foot-rot." "Foot-rot" may attack the wheat plants in patches as is the case with "Take-all" or it may attack isolated plants throughout the crop.

Plants may be killed out by "Foot-rot" in all stages of development, and the occurrence of "whiteheads" is a common symptom. (Fig. 3.) The fungus has fortunately only been rarely found in Western Australia. It has a very wide host range, and various strains may attack wheat, barley, rye, and many different grasses, including barley-grass (*Hordeum murinum*) and various species of brome grasses (*Bromus spp.*). Oats have not so far been found affected in Western Australia, although some varieties are slightly affected in other parts of the world. In this State the disease has so far only been found on wheat and barley grass. Susceptible species may be attacked on the roots, stems, leaves, ears, and grains. The disease is most serious under rather high soil temperatures, and in the presence of abundant moisture. Hynes (*Agric. Gaz. N.S.W.*, Vol. 43, No. 2, p. 115, Feb. 1932) states that "Foot-rot" has been observed in New South Wales to assume epidemic form in both very wet and very dry seasons.

Fig. 3.—Showing wheat plants that have died of "Foot-rot," due to *Helminthosporium sativum*, in various stages of development.

(*Photo. Department of Agriculture, N.S.W.*)

GENERAL CONSIDERATIONS.

The organisms just described may all cause any of the following effects, viz.:—(i) death of wheat plants at a very early stage in their growth, so that large bare patches may appear very early in the growth of the crop; or (ii) death at any later stage, with consequent lack of formation of the heads; or (iii) they may lead to the development of whitened leaves, straws, and heads without grain; or (iv) the formation of heads with very pinched grain, as the case may be. The exact symptoms developed depend, among other things, on the degree of concentration of the fungus responsible, the stage of growth when the plants are attacked, weather conditions, fertiliser treatment, etc.

No field survey has ever been made in this State of the relative abundance and distribution of the separate root-rotting diseases. Specimens of plants

affected with "root-rotting" diseases sent in by farmers, however, are for the most part found in the laboratory to be attacked by "Take-all" (*Ophiobolus graminis*); *Wojnowicia graminis* being very much less commonly found, and "Foot-rot" (*Helminthosporium sativum*) only very rarely.

In the field the effects of the "Take-all" fungus are usually noticed more early in the season than is the case with "Foot-rot," to which attention is more usually drawn by the occurrence of plants in patches, or scattered through the crop, prematurely "whitening-off" towards harvest time.

The stem symptoms described above serve to distinguish wheat plants affected by root-rotting diseases from failures due to water-logging, excessive salt in the soil, soil poverty, frost, or hot drying winds on improperly-consolidated or moisture-deficient soil.

CONTROL OF "TAKE-ALL" AND "FOOT-ROT."

The control measures for the two diseases are sufficiently similar to be considered identical from a practical point of view. Where conscientiously carried out little loss need be feared from either over a series of years, although once they have become established on a farm there may be an exceedingly heavy loss in seasons very favourable for infection.

Unfortunately, as stated above, these diseases cannot be controlled by the use of seed treatment, as recommended by the Department of Agriculture for "bunt" or "ball smut," or by the use of resistant varieties, as recommended for "flag smut" and "rust." Their control can be summed up in the sentence, *"The control of root-rotting diseases of wheat depends on starvation of the fungus and the adoption of all those cultural methods which experience has demonstrated provide for the ideal development and growth of the wheat plant."* Disappointment will result if too exclusive reliance is placed on any one method. Success will depend on the intelligent employment of the following interdependent practices.

1. **A good, clean, stubble-burn in badly-affected patches or paddocks.**—Where only small patches occur, straw from the neighbouring healthy areas should, if possible, be distributed over the diseased areas before firing, so as to make a more intense burn over the badly-affected patches. (Where the disease is serious, there is, of course, only a limited amount of stubble formed, so that the necessity for some additional material for burning is obvious.) The object of a stubble-burn is to destroy as much as possible of the diseased roots and the lower parts of the infected stems and leaves. These are the parts which carry the fungi. The latter do not die with the plants but live either as fungal threads (*mycelium*), or in *spore* (seed-like) form in the dead wheat tissues. If not burnt, the infected parts of the stubble may be blown about the paddock and into other paddocks, especially if broken up by the trampling of sheep and horses. The headlands should also be burnt to destroy self-sown wheat or barley plants, barley grass, brome grasses, silver grass (*Festuca bromoides*), etc., which may be harbouring "Take-all" or "Foot-rot."

Paddocks which have been allowed to go to pasture should preferably be burnt, when possible, before being fallowed, as the growth of such host plants as barley grass, spear grass, silver grass, and a number of other grasses, is one of the most rapid means of greatly increasing the "root-rotting" diseases on wheat paddocks.

While recognising to the full the value of a stubble-burn as an initial step in the cleaning-up of paddocks where "Take-all" and similar diseases have been allowed to get the upper hand, the writer wishes to emphasise, in no uncertain manner, that the indiscriminate and repeated burning of the stubble as a routine practice, year after year, cannot be too strongly deplored, owing to the very serious reduction in soil fertility and marked deterioration in the physical properties of the

soil which may result from the repeated destruction of humus, on the content of which the fertility and good physical condition of any soil to a very great extent depend.

2. **Early Fallowing.**—The importance of this measure cannot be over-emphasised. Results of experiments at the Merredin Agricultural Research Station show an increase of approximately five bushels per acre on early-June-fallowed plots as against those fallowed in late August; the occurrence of "Take-all" on the early-fallowed plots being also very markedly reduced. From a disease point of view the main object of early fallowing is to plough under infected stubble and induce the fungus seeds, or spores, which are produced on the bases of the stems and roots of infected plants, to germinate. Having germinated in the moist soil, these spores must soon find some susceptible plants close handy to attack or else die of starvation.

Unfortunately, a stubble-burn does not destroy all the affected stem-bases, leaf-bases or roots, so that a burn is not sufficient in itself to effectively control these diseases. It is therefore necessary to follow up the stubble-burn by early ploughing in the late autumn or early winter, whenever possible, so as to turn the spores under into the moist soil. This does not cause them to rot, as might be supposed, but induces many to germinate. *If the first ploughing is left till the spring the soil may be too dry to induce copious germination, and many of the spores may not germinate till the following winter, thus putting back the control of the diseases for another year.* Once the spores have germinated they must find something to attack or die of starvation. This brings us to the third point in the control measures, viz.:—

3. **Clean Fallowing.**—It is absolutely essential that all growth should be destroyed by thorough cultivation, and the judicious use of sheep, in the winter and early spring, as otherwise the growth of susceptible plants on the fallows, such as self-sown wheat, barley, barley grass, etc., is simply breeding up and multiplying "root-rotting" fungi for the following year.

If ploughed in the late autumn or early winter (or even if left unploughed till the spring), the winter rains will have induced a more or less plentiful growth of self-sown wheat, barley grass, brome grasses, silver grass and perhaps barley. *These plants may be attacked by the spores already ploughed in, and, in such a case, unless the plants are killed out by clean cultivation, the fungi will eventually form a new crop of spores. Therefore the fallows should be kept free from all growth in the spring.* From July to November, in a cool, moist, spring, or to October in more normal years, it is dangerous, from a disease point of view, for grasses to grow on infected fallows. After that the very high temperatures of the summer will usually prevent both the susceptible plants and the fungi developing.

4. **Avoidance of "Dry Working" of Fallowed or Stubble Land.**—Unless absolutely imperative for the eradication of weeds or the carrying out of some other essential farm operation, *it is most important that the fallows or stubble land should not be worked dry,* as under such conditions the infected stubble, which is very brittle, is broken up into numerous small pieces, which are then blown about by the wind and cause a very rapid increase in the size of the "Take-all" or "Foot-rot" patches, and bring about an extension of the diseases on to hitherto clean areas. *From a disease-control point of view, dry working of the fallows or stubbles cannot be too strongly condemned.*

5. **Rotation of Wheat with Crops not Susceptible to these Diseases.**—The growth of a crop of oats, peas, rape, lupins, lucerne, subterranean or cluster clover, or any other suitable plants not belonging to the Grass Family, following the steps already discussed, viz., a good, clean, stubble-burn, and early and clean fallowing, will give another season for any remaining spores in the soil to germinate and die. Oats have not been found affected by "Foot-rot" in this State, and they are to all

intents and purposes immune from "Take-all." Oats are at present the most practicable crop for rotation purposes. None of the other plants mentioned above is subject to either disease.

6. **Research Work** carried out in recent years by Canadian workers has indicated that crop rotations may markedly affect the composition of the soil flora, and that the "Take-all fungus may be suppressed as the result of the antagonism shown to it by various organisms then able to assert themselves by reason of the new biological balance in the soil.

After the rotation crop the paddocks should preferably be early and clean fallowed before again coming back into wheat.

7. **"Wet-Sowing"** i.e., sowing wheat after the commencement of the autumn rains, not before, when the season allows, gives any fungus spores that may still remain in the soil a further chance to germinate and die before the wheat is sown or germinates.

8. **The Variety Selected** should be planted as *late* as is permissible for the district according to the recommendations of the Wheat Branch of the Department of Agriculture. It is advisable to choose an early or very early maturing variety for planting on paddocks where serious losses from "Take-all and "Foot-rot" have been experienced, because these varieties can be planted later with safety than is the case with later-maturing varieties.

9. **Heavy Dressings of Superphosphate.**—As much superphosphate should be used on "Take-all" patches or paddocks as the farmer can afford, as the "Take-all" fungus is definitely suppressed by any substances which tend to increase, even temporarily, the acidity of the soil. Moreover, extra superphosphate stimulates a vigorous rooting system and induces very considerable disease-resistance, so that the plants are very much better able to resist the attacks of the "Take-all" and "Foot-rot" organisms. These diseases are always very much more serious on wheat plants which have been weakened in any way, such as by the water-logging of the soil, too deep planting of the seed, severe frosting during the spring, or too little use of superphosphate.

It has been shown by Kirby in America (Cornell Uni. Agr. Expt. Sta. Memoir. 88, 1925) that, although "Take-all" can be grown in artificial media with a wide range of acidity or alkalinity, it prefers somewhat alkaline conditions.

During the 1931 season it was found at the Merredin Agricultural Research Station that where "Gluyas Early" wheat had been planted across a "Take-all" patch without superphosphate the wheat was a failure. Where 75 lbs. of superphosphate per acre were used, "Take-all" was serious. Across the same patch where 150 lbs. of superphosphate per acre were used very little "Take-all" could be found, even on close scrutiny.

10. **Good Drainage** is essential on heavy forest country, as where the water tends to lie on the surface for any length of time the effects of the fungi herein discussed are always very much more severe than on well-drained land.

11. **The Wheat Seed should be Planted on a Very Well Compacted Seed Bed** about 1¼ to 1½ inches deep. This is very much more important than many farmers realise. The thorough preparation of the seed bed, so that there is at seeding time a very firm seed bed about 1¼ inches below the surface mulch, is one of the most important factors in ensuring a good even germination and the development of strongly-rooting, abundantly-vigorous, disease-resisting plants. The sowing of wheat on a properly consolidated seed bed stimulates vigorous root development, and by giving the plants a good start in life tends to render them more resistant to the inroads of the fungus diseases herein discussed.

If planted deeper than about 1¼ inches, considerable time and energy is wasted by the young seedlings in developing their permanent root system at the 1¼-inch level, which they will always do no matter how deeply the seed is sown. If the permanent root system is thus forced to develop in a very poorly compacted and over-aerated region of the soil, the resistance to "Take-all" and "Foot-rot" is very greatly lowered.

12. **Do Not Feed-off Crops on Affected Land,** as the reduction in the vigor of the plants which is caused by this practice will result in any "Take-all," or "Foot-rot," which may be present, causing a very much greater loss of yield than would be the case had the crop not been fed-off. These diseases can be present on wheat plants without doing them any very great amount of damage, if the infection is only slight, but anything which reduces the vigour of the plants may allow the fungi to get the upper hand. Similarly, anything which will tend to increase the vigor of the plants will tend to cause them to throw off these diseases.

13. **If Cutting Infected Crops for Hay, Set the Reaper and Binder to Cut Not Closer to the Ground than Four or Five Inches,** so that diseased tissues will not be spread about the farm on the hay, chaff, or in the droppings of animals.

14. **Avoid the Dumping or Stacking of Bags containing Wheat or Chaff in Bare Patches in the Paddocks caused by "Take-all" and Similar Diseases,** as small pieces of infected material may become caught up in the fibres of the bags and be distributed in that way to other parts of the farm, or to new farms, later on.

15. **On No Account should Paddocks Affected with "Take-all" or "Foot-rot" be allowed to go to Pasture.**—Such a procedure does not tend to remedy the position but only makes the diseases worse, as most of the grasses which grow upon pasture land, such as barley grass, spear grass, silver grass, etc., become infected with the diseases without actually being seriously injured themselves. Pasture on "Take-all" or "Foot-rot" patches or paddocks, therefore, makes the diseases worse, instead of better, when wheat is again grown on those areas. It is very much better, from the disease point of view, to adhere to a two-year rotation, i.e., fallow, wheat, fallow, wheat, on heavy soil, than to adopt the three-year rotation, fallow, wheat, pasture, where "Take-all" and similar diseases exist.

To let an infected area go to grass not only does not check the disease on that area, but it is liable to infect adjoining areas through infected fragments of the grasses being blown about by wind, or carried to them on the implements or by stock, etc. (See Fig. 4.)

16. After breaking up grass paddocks the first crop should be oats, where possible, not wheat.

17. **Never Plant Discoloured, Shrivelled Seed,** as "Foot-rot" may cause such symptoms and be introduced on to new areas in infected seed.

18. If it is ever absolutely necessary for any reason to plant wheat after "Take-all" or "Foot-rot" without the intervention of an early, clean fallow, such as recommended above, the best methods are:—*Stubble burn, thorough preparation of the seed bed after rain, shallow planting, the planting of early-maturing varieties as late as is permissible for the district according to the recommendations of the Wheat Branch of the Department of Agriculture, and heavy applications of superphosphate.*

In conclusion, if all the above recommendations are carried out conscientiously—and many of them are simply practices which should be carried out in the ordinary routine of good modern farming, quite apart from all considerations of disease control—"Take-all" and "Foot-rot" will be very greatly reduced in amount, if not entirely eliminated, from the wheat fields.

It is very much better, in every way, to farm a smaller area thoroughly than a larger area in a skimpy and slip-shod manner.

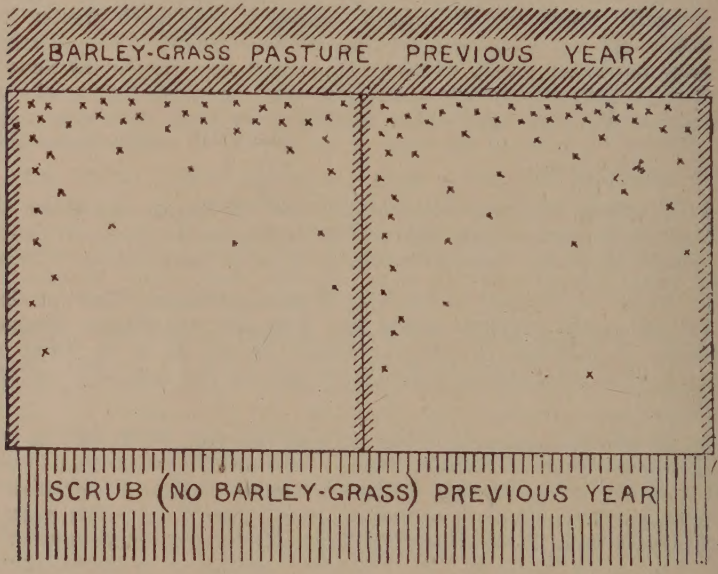

Fig. 4.—Diagram illustrating the manner in which two fields were affected with "Take-all." The crosses indicate the distribution of "Take-all" patches, but are not accurate plottings.

(*After G. Samuel, "Take-all Investigations. 2." Journ. Dept. Agric. S. Aus., July, 1924, pp.* 1134–1147.)

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THE DEVELOPMENT OF PERENNIAL RYE GRASS PLANTS AS AFFECTED BY RATE OF SEEDING.

T. C. Dunne and H. K. Gibsone.

The early attempts made in this State to establish pastures of perennial grasses using seeding rates of 20-30 lbs. per acre were attended by many failures. Normally excellent stands were obtained during the year of seeding but these failed to survive the dry summer months and very few plants persisted.

Experience gained from the earlier experiments suggested that a lighter seeding rate permitting better development of a fewer number of plants might possibly result in fairly large plants which, by virtue of a more extensive root system, would be able to withstand the dryness of summer months.

Under irrigation conditions as practised in the South-West areas, water is usually applied at about monthly intervals. While water requirements in general are fulfilled, there may occur some drying out towards the end of the monthly period. In addition, it was considered possible that a smaller number of better developed plants might better withstand grazing by stock and eventually provide more feed. Furthermore, white clover which is considered an integral constituent of irrigated pastures under our conditions, is often adversely affected by competition from grass species during the early stages of the development of the pasture. A lighter rate of seeding might reasonably be expected to help in the establishment and spread of white clover.

EXPERIMENTS.

In the spring of 1934 three plots, each of three acres, were selected at Waterloo. The soil conditions were good and sowing was done on a well prepared seed bed.

White clover (N.Z. Certified) at the rate of 2 lb. per acre was sown on all plots and perennial rye grass (N.Z. Mother Strain) was sown at the rate of 4 lb., 8 lb., and 16 lb. per acre.

Partial germination followed light rains which fell just after seeding, but this was remedied by good falls in early November. Excellent germination was eventually secured on all plots.

During the summer months, irrigation water was applied at monthly intervals. A fertiliser dressing was given three times a year, viz., during autumn, during spring and during summer.

Throughout the period under review, good growth was obtained on all plots. A record was kept of the amount of grazing obtained.

PLANT DEVELOPMENT.

Early in November plant counts were made to determine the germination on the various plots. At that time complete germination had not occurred and considerable variability was noted. This was emphasised by the figures for white clover which had been seeded at the same rate on all plots. The figures are interesting however as indicating, when compared with the later figures, the mortality of perennial rye grass plants, especially on the heavier seeded plots.

Following are the results of the counts:—

Size of square 7 inches x 7 inches.

Rate of Seeding of Perennial Rye Grass,	Plants of Perennial Rye Grass, Ar. of 30 squares.	Plants of White Clover. Ar. of 30 squares.
4 lb./acre	9.6	10.4
8 lb./acre	30.3	13.3
16 lb./acre	69.9	9.8

During the following months it was noted that the spread of white clover had very definitely been adversely affected by the competition from rye grass on the heaviest seeded plot. Good establishment and growth of clover was observed on both the lighter seeded plots.

In February, 1936, about sixteen months after planting, a number of pieces of turf were taken from each plot. These were dissected and plant and tiller counts of perrenial rye grass made. No attempt was made to count the white clover plants.

The following figures were obtained:—

Rate of Seeding of Perennial Rye Grass.	Average number of Plants per square.	Average number of Tillers per plant.	Average number of Tillers per square.
4lbs./acre	7.4	26.2	204
8lbs./acre	8.6	23.4	201
16lbs./acre	18.5	11.5	215

The figures show a relatively small difference in the number of plants or the development of the plants on the plots seeded at 4 lb. and 8 lb. per acre. However the plot receiving 16 lb. per acre of seed, in spite of the high mortality, had still a much greater number of plants, but these had fewer tillers per plant and were not nearly as well developed. The totals for the tillers on each of the plots are in very close agreement.

The results indicate that, as far as perennial rye grass was concerned, little, if any, gain was obtained by the heaviest rate of seeding.

GRAZING DATA.

At all times grazing was done by cattle. The following data were obtained:—

Cow Grazing Days.

Rate of Seeding of Perennial Rye Grass.

Month.	4 lbs./acre. Days.	8 lbs./acre. Days.	16 lbs./acre. Days.
December	210	210	292
January	50	50	100
February	80	80	80
March	168	168	168
April	72	90	90
May	100	120	140
August	56	70	56
September	60	100	80
October	66	88	66
December	448	448	448
Totals—			
Dec.-May inclusive ..	680	718	870
Aug.-Dec. inclusive ..	630	706	650

The totals from the above data show that in the early stages of the pastures most grazing was obtained from the heaviest seeded plot though this was by no means proportional to the rate of seeding. During the later stages slightly more grazing was obtained from the plot seeded at 8 lb. per acre than from that seeded at 16 lb. per acre, probably due to the better stand of white clover in the former plot. No apparent reason was noted for the discrepancy between the grazing days on the two lighter seeded plots as compared with the tiller counts.

CONCLUSION.

Owing to the less suitable pasture management following a change in ownership of the property whereon the experiment was located, the experiment was unavoidably curtailed.

While the results, therefore, cannot be regarded as conclusive, the figures obtained indicate that a lighter rate of seeding, as compared with earlier views, is conducive to better development of the individual plants without any perceptible decrease in the amount of grazing obtained. In the experiment above described it is possible that a better pasture might eventually be obtained from the plot seeded at 8 lb. per acre than from that seeded at 16 lb. per acre. Observations made on the plots gave the impression that a seeding rate of 4 lb. per acre was lighter than that required for maximum production.

It is realised that under conditions of higher general fertility, using the term "fertility" in its broadest sense, somewhat different figures might be obtained.

THE SALT (SODIUM CHLORIDE*) CONTENT OF RAINWATER.

By L. J. H. TEAKLE,
Plant Nutrition Officer.

SUMMARY.

Analysis of rainwater shows it invariably to contain impurities of which, in non-industrial centres, chlorides, principally salt (sodium chloride) are the most important constituents.

In coastal areas the mean salt content of rainwater may be expected to range from 15 to 50 p.p.m. and in inland areas from 4 to 20 p.p.m. The annual precipitation of salt in rainwater generally ranges from 100 to 600 pounds per acre in coastal regions and from 10 to 60 pounds per acre in inland centres.

Salt brought in by the rainfall and known as cyclic salt is deemed adequate to account for the amount of salt observed in the soils and ground waters in Western Australia. It seems unlikely that the Miocene submergence is a factor in the present condition with respect to the accumulation of soluble salts.

CYCLIC SALT.

Visiting observers have always been interested in the obvious occurrence of salt patches in gullies in the south-western coastal regions of Western Australia, and an interpretation of the phenomenon on the basis of the salt content of rainwater has been attempted by several investigators. It is the purpose of this paper to summarise certain of the published results and to add further information obtained by the writer and associates.

It has long been recognised that rainwater is by no means pure—that it contains appreciable quantities of soluble matter such as common salt, nitrates, ammonia, dust, etc. In the vicinity of industrial centres, sulphates and sulphuric acid, soot, tar and ashes are additional and undesirable contaminants. Generally, however, common salt is the principal and most important impurity, but it is associated with small amounts of other substances of which magnesium and sulphate are the major constituents. The common source of these is sea water, the average percentage composition of which is:—

Sodium (Na).	Chloride (Cl).	Magnesium (Mg).	Calcium (Ca).	Potassium (K).	Sulphate (SO_4).	Bromide (Br).
1·03	1·90	·13	·05	·06	·28	·03

* Sodium chloride is calculated from chloride estimated by titration with standard silver nitrate solution.

If all of the sodium is combined with chloride there would be 2.62 per cent. sodium chloride in sea salts and the remainder 0.86 per cent. would be composed of magnesium chloride, magnesium sulphate, and other compounds. Fine sea spray is lashed into the air by winds, the water evaporates and the residue, largely common salt but containing other salts as well, is carried inland to be deposited as a fine dust or dissolved in the rain. This salt is known as cyclic salt. In the vicinity of salt lakes or salinas, the salt may be derived in part from these local sources but, in principle, the action is the same. Having reached the surface of the soil, it begins to move back to the ocean (or other drainage basin) to complete the cycle —sometimes rapidly, and sometimes slowly; sometimes it may be practically immobilised in low rainfall areas in which drainage is more or less non-existent.

In studying the question of the salinity of the water in the Mundaring Reservoir, Weller (1926) calculated that an average of 28,800,000 pounds of salt is annually brought into the reservoir from its catchment of 569 square miles. This is equivalent to 80 pounds of salt per acre and agrees within very narrow limits with that found to be brought in by the rainfall. It was concluded that the salt concerned is wholly derived from the ocean and is brought to the catchment area by the wind and precipitated with the rain.

The problem was discussed from another point of view by Wood (1923) before the Royal Society of W.A. in 1923. He gave evidence over a period of 25 years which showed an increase in salinity in railway reservoirs, principally in the Great Southern and South-Western districts, following the clearing of the surrounding country. In many cases the increased salinity was traceable to newly formed saline streams entering the reservoir, sometimes on the surface and sometimes in the subsoil, often following the path of decayed roots. It was also observed that in some instances the first water entering the reservoirs with the break of the dry summer period was much more saline than the normal winter supplies, and this was attributed to salt as dust being deposited on the surface of the soil during the summer. Wood concluded that the salt was derived from evaporated sea spray driven inland by the sea breezes or "doctors" which temper the climate of coastal areas at all seasons of the year in Western Australia.

Considerable scientific and practical interest in Wood's paper led the Royal Society to appoint a committee to investigate the matter more fully and a comprehensive report was published in the Journal of the Royal Society of Western Australia for 1929. This investigation involved the analysis of rainwater and the measurement of the strength of prevailing winds during 1926 at a number of coastal and inland centres, but the bulk of the evidence was obtained for the Perth Observatory which is about 5¼ miles east of the west coast.

At the Perth Observatory rainwater was collected and analysed on 100 days of the 164 on which rain fell. On the remaining days very light rain was recorded and was not examined. The information proved that there is a strong positive correlation between the amount and strength of landward winds and the amount of salt in the rainfall. Strong, gusty weather from the western quarter caused the salinity of the rainwater to be particularly high.

Of particular significance are the figures obtained during a storm on the coast between July 18th and July 22nd, 1926, when 4.16 inches of rain were recorded and the total landward wind movement amounted to 3,185 miles for the five-day period. The average salinity of the rainwater in terms of salt was 50 p.p.m. (3.5 grains per gallon) and 45 pounds of salt per acre were deposited. The maximum concentration of salt in the rainwater and the maximum deposition in one day were recorded on July 21st, when the landward wind movement amounted to 1,032 miles, an average of 43 miles per hour. On this day 0.80 inches of rain fell and the rainwater contained 154 p.p.m. salt (10.8 grains per gallon), with the result that 28.0 pounds of salt were deposited on the city of Perth, as represented by the Observatory.

Normally, of course, the rainwater is much less saline. The average for the Observatory in 1926 was 27.2 p.p.m. salt (1.9 grains per gallon) and about 300 pounds of salt per acre were deposited during the whole year. The minimum concentration determined was on September 27th, 1926, when 6 points (0.06 inches) of rain, containing 3.26 p.p.m. salt (0.23 grains per gallon) were recorded.

A certain amount of data for a number of other stations were obtained and are summarised, with those for Perth, in Table 1. It is unfortunate that more complete data could not be obtained but it is considered that reliable deductions are possible and accordingly estimates are included in Table 1. These estimates must be accepted in the light of the data submitted.

TABLE 1.

Summary of information published by the Royal Society of Western Australia (1926) concerning the salinity of rainfall at various centres and the estimated precipitation of salt per acre during 1926.

Station.	Number of Days Recorded.	Total Rainfall on the Days Recorded.	Total Rainfall for Year (1936).	Salinity of Rain Water NaCl.*	Estimated Precipitation of Salt per Acre per annum.†
A.—Coastal:		inches.	inches.	p.p.m.	lbs.
Perth	100	41·33	49·22	27·2	304
Geraldton ...	15	5·48	16·23	47·3	174
Esperance ...	9	8·89	33·42	34·1	259
Cordon	6	5·99	12·52	13·5	38
B.—Inland:					
Coolgardie ...	5	3·07	7·94	19·8	36
Cue	15	4·51	10·34	15·8	37
Mundiwindi ...	12	5·19	7·39	5·8	9·7
Wiluna	6	2·33	6·63	6·6	9·9
Rawlinna ...	3	1·16	3·65	10·4	8·6

* NaCl calculated from chloride ion determined by titration with standard silver nitrate.

† For the purpose of this calculation it is assumed that the total rainfall for the year has the same average composition as that portion actually analysed. Precipitation of salt per acre equals total rainfall × salinity × 0.227 lbs.

THE SALINITY OF RAINWATER AT MERREDIN AND SALMON GUMS.

Further information for Western Australia has been obtained by the writer and his associates in the course of soil alkali investigations in the wheat belt. The water collected in the rain gauges at the Merredin and Salmon Gums Research Stations for the four-year period 1933-1936 was sampled at monthly intervals by the courtesy of the Superintendent of Wheat Farming (Mr. I. Thomas) and analysed for chloride content by Best's method (1929). When insufficient rain was collected during one month, two, and sometimes three or four months' precipitation were bulked for analysis. In all cases the total amount of water collected in the gauges in the usual routine was sampled for analysis so that any salt falling on the gauge in the form of dust would be included in the determination. The Merredin Research Station is approximately 160 miles east of Perth and the Salmon Gums Research Station 65 miles north of Esperance.

The results of this work are summarised in Table 2.

TABLE 2.*

Salt in Rainwater at the Merredin and Salmon Gums Research Stations 1933-1936.

Year	Merredin.	Salmon Gums.
1933—		
Rainfall (inches)	9.67	12.13
Salt—p.p.m.	7.3	9.4
Salt—lbs. per acre	16.2	25.8
1934—		
Rainfall (inches)	13.48	14.95
Salt—p.p.m.	5.7	10.2
Salt—lbs. per acre	17.3	34.8
1935—		
Rainfall (inches)	10.24	11.46
Salt—p.p.m.	5.8	10.1
Salt—lbs. per acre	13.6	26.2
1936—		
Rainfall (inches)	8.81	11.53
Salt—p.p.m.	9.1	8.4
Salt—lbs. per acre	18.2	22.1
Mean of four years by years—		
Salt—p.p.m.	7.0	9.4
Salt—grains per gallon ..	0.49	0.67
Salt—lbs. per acre	16.3	27.2.

*The concentration of salt reported is the weighted average of all determinations during each year.

The average annual salt precipitation at Salmon Gums is about 27 pounds and at Merredin 16 pounds, a ratio of 1.69 to 1, and the difference is due largely to the concentration of salt in the rainfall. If all of the salt precipitated accumulated in the soil it would take over 200 years at Merredin and about 120 years at Salmon Gums to raise the soil to a depth of one foot by 0.1 per cent. salt. In the course of the Salmon Gums and Lake Brown* Soil Surveys it was discovered that the deeper subsoil layers (6-10 feet) contained about 0.6 per cent. and 0.35 per cent. salt at Salmon Gums and Lake Brown respectively. This corresponds to a ratio of 1.71 to 1, which very closely approximates that for salt precipitation and suggests that the salt content of the rainfall is adequate to explain the presence of salt in these soils and also the differential amounts found in the course of the soil surveys.

COMPOSITION OF RAINWATER IN OTHER PARTS OF THE WORLD.

It has been considered by some that the salt precipitation in Western Australia is extraordinarily high. That this is not so is amply demonstrated by information from the literature, Miller (1906) and Crowther and Ruston (1911). For purposes of comparison data collected by these investigators are summarised in Table 3.

The composition of the rain with respect to salt at the stations from which studies are reported resembles that examined in Western Australia and the annual deposition of salt varies between similar limits. The paramount importance of the proximity to the coast and the type of wind is made clear by the data for Western Australia and is emphasised by a figure for Land's End, England, reported by Miller (1906). Rainwater collected at a height of 100 feet above the sea at Land's End analysed 360 p.p.m. salt (25 grains per gallon), a figure which probably approaches the maximum for normal rainfall.

* The Lake Brown soil survey was carried out in an area 25 to 40 miles north of Merredin township.

TABLE 3.

Composition of rainwater from various parts of the world from figures reported by Miller (1906) and Crowther and Ruston (1911).

Investigator.	Centre.	Country.	Annual Rainfall.	*Salt (NaCl) in Rain Water.	*Salt Deposited by Rain.
			inches.	p.p.m.	lbs. per acre per annum.
Miller ...	Rothamstead	England	27·25	3·8	24·5
Do. ...	Circencester ...	do. ...	30·61	5·2	36·1
Crowther & Ruston	Leeds (Suburban-Garforth)	do. ...	26·95	5·6	34·5
Do. ...	Leeds (Industrial Stations)	do. ...	26·95	27–54	160 to 330
Miller ...	Perugia ...	Italy ...	33·96	5·2	40
Do. ...	Scandicci ...	do. ...	27·67	9·3	58
Do. ...	Catania ...	do. ...	18·36	9·0	38
Miller ...	La Guardia ...	Spain ...	56·42	51·4	660
Do. ...	... ...	New Zealand	29·70	14·5	98
Do. ...	... ...	Barbados ...	63·95	13·4	211
Miller ...	... ...	British Guiana	102·41	8·3	193
Do. ...	... ...	Ceylon ...	82·13	16·0	298
Do. ...	Calcutta ...	India ...	46·01	5·2	54
Do. ...	Madras ...	do. ...	39·21	6·7	60

* Calculated from chloride.

These soluble salts are generally regarded as more or less innocuous and may be an advantage in the growth of special crops such as artichoke and beet. Considerable concern, however, has been occasioned by other and highly undesirable impurities in the vicinity of large industrial centres. The late Julius Stoklasa has been one of the foremost investigators of the problem in Germany, and, in England, Crowther and Ruston (1911) have thoroughly investigated the conditions near Leeds.

Crowther and Ruston found that the maximum quantity of suspended impurities deposited per acre per annum at Leeds amounted to 1,886 pounds, composed of 110 pounds of tar, 663 pounds of soot and 1,113 pounds of ash. In addition, considerable quantities of sulphuric acid were deposited, the maximum amount recorded being 90 pounds per acre per annum. Normally, there would be no sulphuric acid in rain water.

These impurities lead to the stunting of the growth of plants and prevent entirely the growth of more sensitive varieties. The suspended impurities reduce the intensity of sunlight by as much as 40 per cent., and the soot and tar block the stomatal openings of the leaves and retard the absorption of carbon dioxide and the exhalation of oxygen. Leaves badly coated were able to assimilate only 11 per cent. of the normal amount of carbon dioxide for clean leaves. The sulphuric acid in the rain water also proved deleterious to the leaves directly and caused serious damage to the soil by promoting acidity.

Fortunately, in Western Australia damage from such sources is almost non-existent, but the possible importance of the salt content of the rainwater in the accumulation of salts in soils in the agricultural areas is of considerable interest and practical moment.

THE INCIDENCE OF CYCLIC SALT.

The data from the Merredin and Salmon Gums Research Stations afford an opportunity for some study of the incidence of the salt precipitation.

Figure I. shows the relationship between monthly precipitation and amount of salt deposited in pounds per acre at Merredin and Salmon Gums during the four-year period under test and Table 4 gives the four-year means for each station.

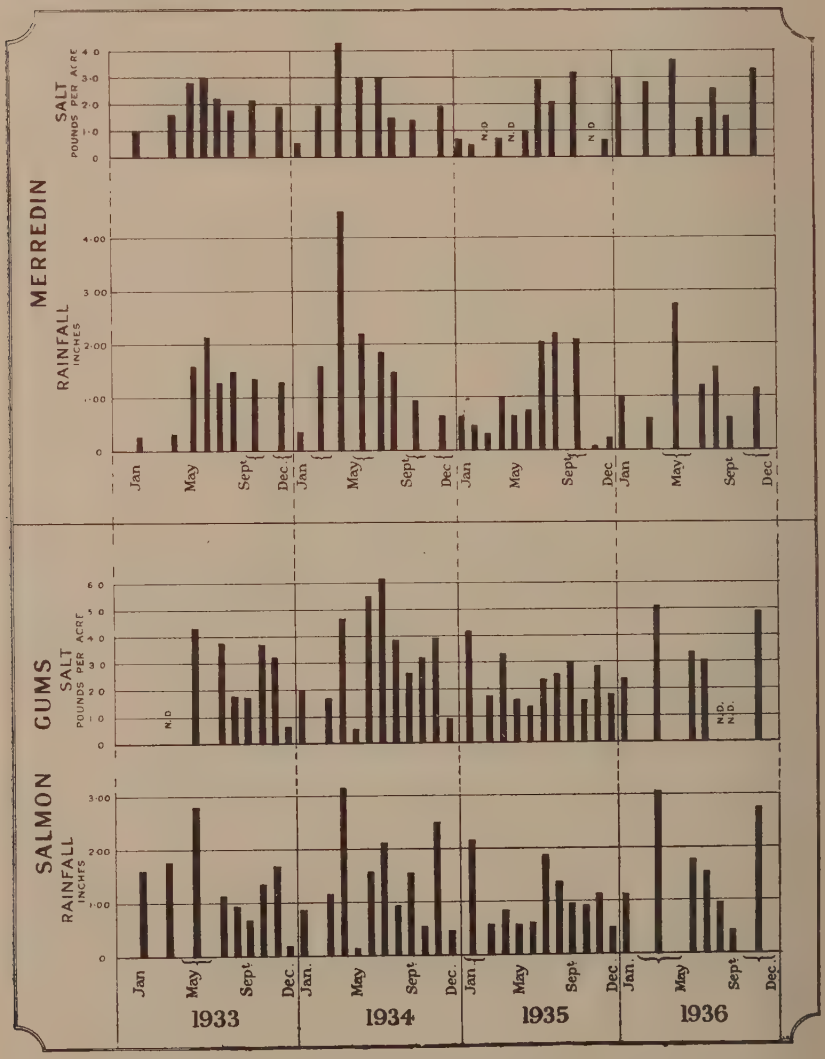


Fig. 1.—Graphic representation of the relationship between the monthly rainfall and the magnitude of the monthly deposition of salt, in pounds per acre, at the Merredin and Salmon Gums Research Stations, 1933 to 1936.

TABLE 4.

Amount of Salt Collected in the Rain by Months at the Salmon Gums and Merredin Research Stations.

Mean of Four Years' Results, 1933–36.

	Merredin Research Station.		Salmon Gums Research Station.	
	Rainfall.	Salt.	Rainfall.	Salt.
	inches.	lbs. per acre.	inches.	lbs. per acre.
January	0·54	1·25	0·98	2·09
February	0·14	0·16	0·48	0·93
March	0·62	1·59	0·90	1·74
April	1·43	1·49	1·14	2·24
May	0·80	1·24	1·09	1·99
June	1·68	2·27	1·32	3·08
July	1·59	2·39	1·66	3·83
August	1·67	1·97	1·04	2·66
September	0·59	1·06	0·90	2·08
October	0·66	1·05	0·76	2·20
November	0·27	0·62	1·42	2·65
December	0·55	1·26	0·82	1·77
Total	10·54	16·35	12·51	27·24

There appears to be a maximum deposition of salt in the winter months, June, July and August, at both stations and a minimum in February, but considerable amounts of salt may be collected in the rain during any season.

At Merredin there is quite a strong correlation between the amount of rainfall and the amount of salt deposited by months but at Salmon Gums the correlation, while apparent, is far less marked. For Salmon Gums all that can be said is that months of high rainfall are months of high salt deposition but quite considerable amounts of salt may be deposited with a relatively low rainfall.

This brings up the matter of the composition of the rainfall and again it is very difficult to observe precise correlations between rainfall and salt concentration. From the data it may be concluded that in months of high rainfall the salt concentration of the rainwater tends to be lower than in months of low rainfall.

The position is represented in Table 5.

TABLE 5.

Composition of Rainwater in Relation to the Magnitude of the Monthly Precipitation.

Monthly Rainfall Range.	Merredin Research Station.			Salmon Gums Research Station.		
	Number of records during—		Salt in Rainwater (NaCl).	Number of records during –		Salt in Rain water (NaCl).
	Summer months.	Winter months.		Summer months.	Winter months.	
inches.	Nov.-Apl.	May-Oct.	p.p.m.	Nov.-Apl.	May-Oct.	p.p.m.
0–0·50 ...	10	4	11·3 (5·3–23·5)	9	2	10·6 (6·8–24·7)
0·50–1·00 ...	7	6	8·9 (3·1–20·5)	3	8	13·4 (7·4–26·0)
1·00–2·00 ...	1	9	6·1 (4·4–7·6)	5	10	9·2 (5·6–15·3)
Above 2·00 ...	0	4	5·2 (4·2–6·3)	2	3	8·3 (6·5–12·9)

At Merredin, the lower concentration of salt in the rainwater in high rainfall months is much more definite than at Salmon Gums. This is probably due to the proximity of Salmon Gums to the Southern coast which is noted for strong southerly sea breezes. A number of climatic factors will influence the collection of sea-spray in the atmosphere and insufficient data renders it impossible to extend the discussion here.

DISCUSSION.

Until recently it has generally been assumed that the salt in our soils and ground water is largely of geological origin—that is, it represents the remains of an ancient submergence when the ocean was thought to extend as far north as about latitude 29deg. S.* during Miocene times. The cyclic salt theory suggested by Wood (1923) received only scant support in Western Australia, although in South Australia, Jack (1914) has been a strong advocate and had presented much data and argument in support.

In the discussion of Wood's (1923) paper, Montgomery, then State Mining Engineer, suggested that the recognised Cainozoic (Tertiary) submergence of the southern portion of Western Australia accounted for at least a portion of the salt in the soils of the State. Simpson (1926, p. 642) associated the incursion of the Miocene sea with the occurrence of salt in the soils and ground water of the south central portion of the State as represented by Merredin and Salmon Gums.

While there is a possibility that the huge deposits of salt in some of the salt lakes or salinas of Western Australia may be related to a Miocene submergence, there is now a large body of opinion, based on more recent observations, to the effect that it is very likely that the cyclic salt theory will account for the occurrence of salt in soils and ground waters generally. The Miocene submergence began about 40,000,000 years ago and the formation of the ironstone gravels, commonly associated with sandplains of the interior, is certainly more recent than this period. As these gravels require moist conditions for their formation it is evident that since Miocene times, Western Australia has enjoyed a period of much better rainfall than pertains at present. Further evidence in support of this hypothesis is adduced by Finlayson (1936) in his discussion of the mammals of the desertic interior. The feeble specialisations of Australian desert fauna to the desertic conditions leads him to conclude (p. 57) that "if . . . . the centre is a desert, then at least it is the veriest newcomer amongst deserts, and many of its denizens retain . . . . habits which must have obviously been developed under much less rigorous conditions of climate than now obtain." Amongst the flora of the Livesey Ranges near the Western Australian border north of the Nullarbor Plains is a patch of blackboy (Xanthorrhoea sp. unknown), a genus typical of the high rainfall areas. Similar occurrences have been reported east of Wiluna and east of Leonora and it is suggested that this affords botanical support for Finlayson's conclusion.

It seems unlikely that any considerable portion of the salt at present in the soils and ground waters of Western Australia has been derived from the Miocene sea.

Considering the factor of cyclic salt alone and assuming the unconsolidated material above the rock to be 50 feet deep, in the total absence of drainage it would take 37,000 years to raise the soils at Salmon Gums to 0.6 per cent. salt and 35,000 years to raise the soils at Merredin to 0.35 per cent. In view of this there seems little reason to postulate that the salt in Western Australian soils and waters have their origin in a sea which existed 40,000,000 years ago.

In the face of this there seems little that man can do to control the forces associated with the occurrence of salt in the soils of Western Australia. It is known, however, that, under virgin conditions, an equilibrium has been established

* Mingenew and Leonora may be taken to represent the location of latitude 29° S.

in which the ratio between the percentage of salt in the soil and the percentage of salt in rainwater is about 500 to 1 under a 13-inch annual rainfall. With the clearing of the country under this rainfall, the soluble salts are rapidly leached from light textured soils and slowly, if at all, from heavy textured soils. Even in heavy textured soils, this ratio would be expected to widen in cultivated country and certain, if slow, improvement should result.

This improvement in the shape of leaching of soluble salts following the clearing of the country brings other problems as the ground water level tends to rise and is known to have risen under a 13 to 20-inch annual rainfall. With the rise of the water table low-lying areas and portions of valleys are liable to become affected with salt encroachment. As far as is known little can be done in many of these instances except to establish salt tolerant pastures and, where possible, to complete the cycle by facilitating drainage and the removal of the salt to the sea whence it came.

ACKNOWLEDGMENTS.

The writer wishes to acknowledge with thanks the assistance of Mr. G. H. Burvill and other members of the Staff of the Department of Agriculture in gathering this information, and of Mr. R. Smith in the compilation of the data.

Grateful acknowledgment is made of the courtesy of Dr. E. S. Simpson in reading the manuscript and in making helpful suggestions and criticisms.

LITERATURE CITED.

Miller, N. H. J., 1906:
The amounts of nitrogen as ammonia and nitric acid, and of chlorine in the rainwater collected at Rothamsted. Jour. Agric. Sci., 1: 280-303, 1905-6.

Crowther, C., & Ruston, A. G., 1911:
The nature, distribution and effects upon vegetation of atmospheric impurities in and near an industrial town. Jour. Agric. Sci., 4: 25-55, 1911.

Wood, W. E., 1923:
Increase of salt in soil and streams following the destruction of the native vegetation. Jour. Roy. Soc. West. Aust. 10: 35-47, 1923.

Weller, W. K., 1926:
Note on the salinity in the Mundaring Weir, Trans. Aust. Ass. Adv. Sci., 18: p. 633, 1926.

Simpson, E. S., 1926:
Problems of water supply in Western Australia, Trans. Aust. Ass. Adv. Sci., 18: 634-674, 1926.

Best, R. J., 1929:
A rapid electrometric method for determining the chloride content of soils. Jour. Agric. Sci. 19: 533-540, 1929.

Royal Society, 1929:
Salinity of rain in Western Australia. Jour. Roy. Soc. West. Aus. 15: xxii.-xxx., 1929.

Finlayson, H. H., 1936:
The Red Centre, Angus & Robertson, Ltd., Sydney.

ERRATUM.

"Journal of Agriculture," March, 1937.

P. 46: "1.303 acres" in lines 19 and 23 should have read "1.803 acres."

SUBTERRANEAN CLOVER SEED.

REGULATIONS REGARDING CONSIGNMENT TO OTHER STATES.

G. R. W. MEADLY, Acting Government Botanist.

The production of Subterranean Clover seed in Western Australia is now an appreciable industry and many tons are consigned annually to the Eastern States. Unfortunately, growers and agents have not always made themselves fully conversant with the regulations existing in the States to which seed has been forwarded, and during the last season several large consignments were held in quarantine at Sydney pending satisfactory information from this State.

These delays were caused by non-conformation with regulations framed to prevent the introduction of Clover Springtail or Lucerne Flea (*Sminthuris viridis*) eggs along with the seed. The two States concerned in this regard are New South Wales and Tasmania and for the benefit of growers or agents who intend forwarding clover seed, their regulations pertaining to Lucerne Flea are appended.

NEW SOUTH WALES PLANT DISEASES ACT, 1924.

(Proclamation 12th January, 1934.)

3. (b)—

(i) The plants shall not have been grown within a radius of five miles of any land upon which Lucerne Flea exists or has existed, or if so grown the whole of the land within the said radius shall have been adequately inspected during the period from the first day of May to the thirty-first day of October immediately preceding the date of shipment of the plants to New South Wales, and the land upon which the plants were grown and the land within a mile thereof shall have been free from Lucerne Flea and there shall have been produced to the Inspector at the port or place of entry a certificate in or to the effect of Form 1 hereto by an Inspector or other authorised officer of the State, country or territory from which the plants were imported, introduced or bought; or

(ii) in respect of lucerne, clover, beans, peas (field and garden), vetches, potatoes and onions, the plants shall have been fumigated for a period of not less than twenty-five hours with carbon bisulphide gas generated from eight pounds (8 lb.) of liquid carbon bisulphide to every thousand cubic feet content of the fumigation chamber, in such a manner that the liquid has rapidly evaporated and the gas has come into contact with every part of the plant, and there shall have been produced to the Inspector at the port or place of entry a certificate in or to the effect of Form 2 hereto by an Inspector or other authorised officer of the State, country or territory from which the plants are imported, introduced or brought. In addition, the covering or package containing potatoes or onions shall be marked on the exterior thereof in letters not less than two inches in height with the name and address of the grower thereof; or

(iii) in respect of the seeds of lucerne, clover, beans, peas (field and garden) and vetches, the seeds shall have been accompanied by a statutory declaration that the seed has been machine-dressed and does not contain more than .05 per centum of soil.

TASMANIA—PLANT DISEASES ACT, 1930—REGULATIONS.

Importation of Subterranean Clover and Potatoes.

Part II.

Conditions of Importation of Subterranean Clover.

(1) In this regulation "leguminous plants" means plants of Subterranean Clover.

(2) Leguminous plants may be landed only at the ports of Hobart, Launceston, Devonport, and Burnie.

(3) Any person intending to import any leguminous plant into this State from any State of the Commonwealth shall give notice, in writing, to the inspector at the port of entry of his intention so to do, at least 24 hours before the time when the plants would, in the ordinary course, be landed.

(4) Except as provided by Subregulation (5), no leguminous plant shall be imported into this State unless it is accompanied by a certificate under the hand of an inspector appointed by the Government of the State from which the same is imported, certifying that the inspector is satisfied that such plant has been grown on land free from the insects known as Lucerne Flea, Black Sand Mite, Red-legged Mite, and Lucerne Weevil.

(5) Seeds of leguminous plants may be imported if, instead of such certificate, the seeds are accompanied by—

(a) A statutory declaration by the person exporting such seed that such seed has been machine dressed, and does not contain more than 0.05 per centum by weight of soil as distinguished from other inert matter; and

(b) a certificate issued by the Department of Agriculture of the State from which the seed is imported, certifying that the seed has been fumigated by an approved person by the hydro-vacuum treatment (consisting of fumigation with carbon bisulphide at 25 lb. per 1,000 cubic feet for at least one hour under the 28 inches mercury vacuum) or some other treatment approved by the Director—

and each bag containing the seed is sealed with the seal of the person performing the fumigation process.

(6) All leguminous plants which have been imported shall be landed and placed in quarantine by the importer under the supervision of the inspector, and there inspected by him.

(7) If after inspection the plants are found to be free from any insect, and the inspector is satisfied that they can be delivered to the importer without danger of introducing any insect, he may issue a permit authorising the delivery of such plants to the importer.

(8) If after inspection any leguminous plants are found to be infected with any insect, such plants shall be—

(a) destroyed at the place of quarantine by the inspector or under his supervision; or

(b) if the importer so desires, reshipped and exported by him.

Provided that before reshipment of the seeds of leguminous plants which are found to be infected by an insect, a proportion not exceeding five per centum of the seed shall be stained by the inspector with fine polishing rouge, or with basic fuchsin, at the expense of the importer.

(9) Where an importer elects to reship any leguminous plant, such plant shall be reshipped under the supervision of the inspector, and until reshipped shall remain in quarantine.

(10) The importer of any leguminous plants shall comply with any orders and directions given by the inspector in connection with such plants.

WHEAT VARIETIES IN WESTERN AUSTRALIA.

R. P. ROBERTS,
Agricultural Adviser.

In the following table are shown the acreages of the more important varieties of wheat planted in Western Australia in 1936. The acreage figures which were supplied by the Government Statistician were obtained when the acreage forecasts were collected in August, 1936. Similar information for 1934 and 1935 was published in this Journal in December, 1935.

1936 SEASON.

Variety.	Position.	Acreage (000's).	Approximate percentage of Total.
Bencubbin	1	891	31·9
Gluclub	2	335	12·0
Merredin	3	274	9·8
Gluyas Early	4	232	8·3
Totadgin	5	195	7·0
Nabawa	6	175	6·3
Noongaar	7	158	5·7
Waratah	8	88	3·2
Ford	9	57	2·0
Geeralying	10	46	1·6
Gallipoli	11	39	1·4
Baroota Wonder	12	37	1·3
Bena	13	30	1·1
Gresley	14	22	0·8
Sword	15	21	0·8
Canberra	16	20	0·7
Rajah	17	17	0·6
Ranee	18	13	0·5
Bald Early	19	11	0·4
Sutton	20	10	0·4
Other Varieties	...	120	4·2
Total	...	2,791	100%

"Bencubbin" and "Gluclub" still maintain first and second places with slightly increased acreages and percentages as compared with the previous season. "Merredin" and "Gluyas Early" remain in the same respective positions as last year, but they have lost ground slightly and will probably have to give way shortly to "Totadgin," another early-maturing variety, which has advanced from 4.3% in 1935 to 7.0% in 1936.

"Nabawa" has dropped back from 8.0% of the total acreage to 6.3%, while the acreage under "Bena" has been nearly halved.

The area devoted to the four main "premium" varieties, Pusa 4, S. H. J., Carrabin, and Comeback, remains substantially the same as in 1935, namely, about 1% of the total, despite the higher price offered by millers.

TOXIC PARALYSIS (BOTULISM) OF CATTLE—PREVENTION NOW POSSIBLE.

H. W. Bennetts, D.V.Sc.

For many years this disease has been responsible annually for the death of large numbers of cattle in the South-Western Division of this State. Stockowners now, unfortunately, are only too familiar with the disease, but the measures of control so far recommended have not proved entirely satisfactory, and it is unlikely that any effective treatment will be evolved for the curing of sick animals. A reliable method of prevention is, therefore, urgently needed, and the purpose of this article is to draw the attention of stockowners to a very promising and cheap method which we are now able to recommend, *i.e.*, preventive inoculation with a vaccine "Botulinus Toxoid."

1.—*The Disease.*

Before discussing the method of prevention, a few comments about the disease itself will not be out of place. The disease results from the eating of bones or other carcase material containing the extraordinarily powerful toxin or poison of a germ (*Bacillus botulinus*) which grows and produces its toxin in decaying animal or vegetable material. It is possible for cattle to become affected from eating contaminated fodder, but with few exceptions they obtain the toxin from carrion.

The disease generally occurs in the dry summer months, and milking cows, particularly heavy producers, are most commonly affected. The depraved appetite which causes cattle to eat carrion is attributed to phosphorus deficiency, the summer feed being poor in this mineral, which is required in large amounts for milk production. Supplementary feeding of phosphates, as licks or given in the feed, has been recommended for the control of carrion-eating and thus for preventing the disease. The results with regard to the prevention of toxic paralysis have been somewhat inconsistent, although the use of phosphates, during the dry period, is to be commended because of the resultant beneficial effect on general health and milk production.

Toxic paralysis could be prevented almost entirely if cattle were denied access to any carrion, but it is practically impossible to ensure that even small paddocks are kept entirely free of carcase material. The symptoms and other aspects of the disease have already been discussed in this Journal by the Chief Veterinary Surgeon (Mr. A. McK. Clark). His article as Leaflet No 230 is available on application.

2.—*Preventive Inoculation.*

The vaccine, Botulinus Toxoid, used for the protection of sheep against toxic paralysis has given such excellent results during the past two seasons, that it was decided to determine whether the same vaccine would effectively protect cattle. The vaccine was tested under experimental conditions and in the field.

An experiment was carried out at the Avondale Research Station, Beverley. In January, 1937, six cattle were inoculated with 2 c.c. of toxoid and two months later were given a second inoculation of 10 c.c. One month later they were tested for resistance to the disease by inoculating them with the dried poison of the germ, prepared in the laboratory. This toxin can be standardised, and when kept dry will retain the same degree of toxicity almost indefinitely. Prior to testing the inoculated cattle, the M.L.D. (the smallest amount which will kill) was tested by inoculating a number of cattle which had never received vaccine, with graded doses of the toxin. It may be of interest to comment that this was so potent that one ounce would kill 24,000 cattle.

The vaccinated cattle were tested for degree of resistance to the disease by inoculating them with this test toxin: two received 20 M.L.D., two received 100 M.L.D., and two received 500 M.L.D. All protected cattle survived the inoculation, and only one of them (one receiving the largest dose) showed any signs of the disease. Two unprotected, control, cattle inoculated at the same time with 2 M.L.D. of the toxin both died. The vaccine will then protect cattle against at least 500 fatal doses of toxic paralysis toxin. This is a very severe test, particularly as the toxin was inoculated instead of being given by the mouth. It seems very unlikely that cattle under field conditions would eat more than 10 M.L.D. of toxin in carrion on any one occasion. The absorption of such repeated non-fatal doses of toxin would on the other hand serve to fortify the immunity conferred by the vaccine. It is reasonable to assume, therefore, that vaccination as detailed should effectively protect cattle against the disease even when there is abundant toxic carrion available.

3.—*Recommendation.*

As a result of the data presented, the use of botulinus toxoid for the prevention of toxic paralysis in cattle is definitely recommended.

Two inoculations, the first of 2 c.c. and the second of 10 c.c., are necessary. The interval between the two inoculations should be two months. It would be advisable to give the first dose early in July and the second in September, so that the inoculated cattle will be protected before the advent of dry feed in October. The cost of the vaccine will be approximately sixpence per head, but it will be necessary also for stockowners to provide themselves with a hypodermic syringe and needles identical with those used for the inoculation of sheep against braxy-like disease or toxic paralysis. The cost is approximately 20s.

The inoculations are made under the loose skin of the neck or behind the shoulder. Arrangements will be made for the demonstration of the method by a departmental officer.

The vaccine is prepared by the Commonwealth Serum Laboratories, Melbourne, and will be issued, for the present, from this Department. Stockowners desirous of protecting their cattle should make application to the Chief Veterinary Surgeon at once so that adequate vaccine will be ordered for their requirements. The vaccine takes some weeks to prepare and delay now will mean delay and, possibly, disappointment later.

THE NEED FOR DIPPING SEED POTATOES FOR THE CONTROL OF RHIZOCTONIA.

E. T. MORGAN,
Officer in Charge, Potato Branch.

Rhizoctonia or Rosette is well known to the majority of potato growers, its effect showing in the field in small green tubers growing "up the stem" and, on tubers, as resting bodies or as black specks firmly fixed on the potato. These black bodies or sclerotia are not easily rubbed or washed off.

It is unfortunate that many of the swamps, in which seed potatoes are produced, carry much of the Rhizoctonia fungus. This is in common with potato growing areas throughout the world; the trouble being the most widespread of all

potato diseases. In new land, few of the tubers carry the disease, but as many of our swamps are getting "older" the trouble is on the increase and very few lines of seed potatoes are even comparatively free of the disease. Rhizoctonia, however, can be almost entirely eliminated by the treatment of seed with a solution of corrosive sublimate, and if the grower is willing to go to the slight trouble of treating his seed the presence of this disease in a limited amount should not prevent the use of seed so infected, if it is known to be otherwise of high quality.

If potato tubers or sets badly affected with Rhizoctonia are planted, the grower is taking the risk of many "misses" in the crop, or perhaps just as the growth seems to be thriving, the tops of many of the plants begin to roll up; small greenish tubers appear in the axils of the leaves, and the crop correspondingly suffers. Environmental conditions seem to play a big part, the disease flourishing most readily under acid soil conditions. Liming would therefore have a good effect but unfortunately this operation favours the organism which causes Common Scab.

In spite of the fact that acidity favours Rhizoctonia, heavy dressings of organic matter, such as green manures, considerably reduce the occurrence of the disease. Fortunately the same applies to Common Scab, except where fresh farmyard manure is concerned, so that here we have a means of somewhat alleviating the effects of both diseases. Temperatures also play an important part, and in some years considerable infection is evident and in others very little shows, possibly because of temperature influences.

The grower, knowing that many of his seed tubers are affected, is often inclined to take a risk and hope that little loss will occur. If the season favours the disease, he then wishes that he had dipped his seed prior to planting by which means he would have considerably reduced the trouble.

Corrosive Sublimate (mercuric chloride) is the chemical most commonly employed for the disinfection of seed potatoes in this State, and this chemical is used at the rate of 4 ozs. to 25 gallons of water. Corrosive Sublimate is somewhat difficult to dissolve and it will be found that hot water is necessary to accomplish this operation quickly. If the chemical is in the form of crystals, these should be pulverised to a fine powder before dissolving. If the powder is placed in a bottle with hot water and thoroughly agitated, a short while only is required to bring it in proper condition for pouring into the water.

The tubers, unsprouted or uncut, should be soaked for 1½ to 2 hours in the solution in wooden, earthenware or cement containers after which the potatoes should be spread out to dry. The solution weakens with use, especially if much dirt is present on the surface of the tubers, or if the tubers are dipped in the bags, so that one ounce of dissolved sublimate should be added to the solution after approximately each 4-bag dipping. There is a prejudice all over the world against the dipping of seed potatoes in the bags, on account of the absorption of much of the chemical by the bags, nevertheless it has been the practice for many years amongst growers in the South-West to so dip their tubers, allowing the bags to remain in the dip for approximately half an hour, allowing about 5 minutes for drainage, the bags then being stacked in wet condition allowing ventilation spaces between, to dry out the stacks. Containers for dipping potatoes are made sufficiently large to accommodate two bags at a time, and if made of metal are given two good coats of tar which is allowed to dry prior to the commencement of operations. By employing two such dips, arrangement can be made to handle one bag every 7½ minutes, a big consideration in dealing with large quantities of seed.

I do not want to convey the impression that this latter method of dipping is as effective as soaking the tubers in racks or crates for 1½ to 2 hours and allowing to dry, as previously quoted, but it is better than doing nothing at all and in the field quite good control of the disease has been noted.

It has also been noted that dipping in very cold weather has tended to retard germination somewhat, so it is advisable to add some boiling water to the solution so that its temperature shall be about 60 degrees Fahrenheit but not above 80 degrees.

It is hoped that growers will realise the necessity, at all times, for the dipping of seed tubers in order to lessen one of the risks which attends potato growing.

Note.—Corrosive Sublimate is deadly poisonous to human, animal and plant life. In addition, it is colourless, odourless and comparatively tasteless. It should, therefore, be used with great care and kept out of the reach of children or farm stock.

Reference.—H. A. Pittman, Journal, Department of Agriculture, W.A., Vol. 8 (2nd series), No. 4, 1931.

WILD VERBENA OR PURPLE TOP.

(*Verbena bonariensis* Linn.)

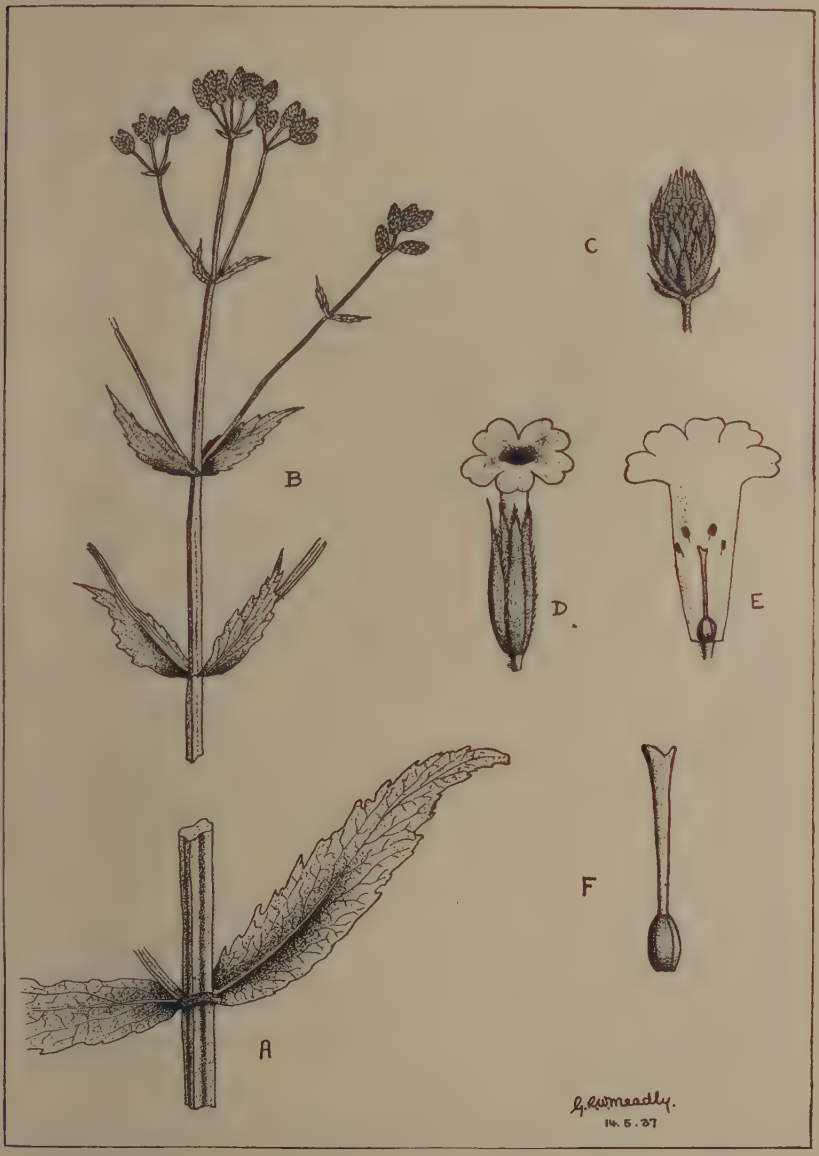
G. R. W. MEADLY,
Acting Government Botanist.

To commence with a platitude which bears repeating, one of the most important factors in weed control is the early recognition of weeds. A specimen from Denmark submitted recently by Mr. H. G. Elliott proved to be Wild Verbena or Purple Top (*Verbena bonariensis* Linn.). Only a few plants were detected and, following identification, these were destroyed. If they had been allowed to multiply for a number of years, complete eradication would have been a far more costly undertaking.

Wild Verbena, a native of the Argentine, was recorded as a naturalised alien in Queensland and New South Wales prior to 1870 and has been present in Victoria and South Australia for many years, but this constituted the first official record for Western Australia. Although not classed among the more serious perennial weeds such as St. John's Wort, Skeleton Weed and Blackberry, it is a free seeding plant which spreads rapidly on waste lands and encroaches on pastures. According to Eastern States reports stock never eat it, except by accident, this type of feeding apparently serving as a beneficial pruning. Although not regarded as harmful to stock an allied species, *V. venosa,* is reported to cause gastric irritation. As the plant has no condoning features and a number of unwelcome ones a watch should be maintained and the accompanying description and drawing serve to assist identification.

Description.—An erect, coarse, rigid herb of 2-6 feet, developing from a perennial stock. The acutely four-angled and roughly hairy stems are little branched. The leaves are sessile, lance-shaped or oval-lance-shaped, up to 5 inches long, coarsely toothed, hairy, the upper ones distant, small and narrow. The flowers are blue in dense spikes of ½-¾ inch, usually clustered at the ends of the branches of a rigid trichotomous panicle. The calyx is five-toothed, about 4 mms. long, the corolla tube 5-7 mms. long, hairy outside and in the throat, the lobes broad and spreading.

Botanical Name.—Verbena was the name applied by the German botanist Otto Brunfels, in 1530, to *V. officinalis*, apparently from verbena, the Italian and Spanish name of this plant, the classical latin name of which was verbenaca; bonariensis is the latinised adjectival form of Buenos Ayres, the capital of the Argentine Republic, South America, the home of this particular species.



(*Verbena bonariensis* Linn.)

DESCRIPTION OF THE PLATE.

A. Lower leaves and stem. (× ½)
B. Inflorescence and upper leaves. (× ⅛)
C. Single head of flowers. (× 1)
D. Single flower and bract. (× 5)
E. Flower opened to show stamens and pistil. (× 5)
F. Pistil. (× 10)

NOTES ON LAMB MARKING.

By HUGH MCCALLUM, Sheep and Wool Inspector,
Department of Agriculture.

Despite advice issued by officers of this Department, through the Press and the Journal of Agriculture, many sheep owners still sustain serious losses through failure to use a little care and cleanliness in lamb marking.

The most desirable lamb carcase cannot be produced from a lamb that has not been docked and castrated. Ram lambs produce coarse inferior meat. Apart from this, every experienced lamb breeder recognises the fact that the quieter his lambs are kept, the bigger the gains they make. The presence of a few ram lambs causes restlessness in the entire flock.

Castration prevents undue development of the head, neck and front quarters. Desexed rams may be run with the ewes. Thus castration makes for easier flock management. Another important advantage lies in the fact that castrated lambs develop earlier. It has been found that ewe lambs take an average of nine days longer than wether lambs to reach similar preslaughter or carcase weights. Early shipping is essential for good lamb prices and even a few days gained may make a considerable difference to the profits of the fat lamb breeder.

The lamb's tail renders no substantial benefit to the animal. On the contrary, its presence is injurious because of the filth that accumulates around and beneath it. Moreover, lambs are more attractive and look deeper in the leg and twist if the tail is docked. Females with full-length tails are likely to fail to breed.

Lambs may be marked at ages ranging from a few days to five or six weeks—the earlier the better.

The choice of site for operations is an important consideration. It is advantageous to erect temporary yards away from dust and dirt as there is always a danger of tetanus and other pathogens in manure-strewn stock yards. The safest time for lamb marking is cool, dry weather. Never castrate in wet or frosty weather.

Sheep should be mustered some time before, and lambs allowed to settle down before operations commence. There should be no rushing about and dogs should be used as little as possible. Many deaths from hæmorrhage are due to operations when lambs are in an excited and overheated condition.

Cleanliness in tools should be a first consideration. All metal instruments lack cracks where bacteria may lodge and are easily disinfected. They should be sterilised between operations by immersion in some disinfectant such as carbolic solution.

The operations should be performed in the following order:—(1) Earmarking; (2) Castration; (3) Tail-docking. The catcher should be quiet yet careful in handling the lambs, and should grip their legs firmly but not too tightly, placing the lamb on its rump on the rail of the yard, the back of the lamb against the catcher's chest. On no account allow the legs to be pulled too far apart, as this often injures the limbs of the lamb.

After the earmarking, the operator takes the tip of the purse (scrotum) between the thumb and first finger and with a sharp knife cuts just enough off the purse to allow the testicles to be grasped by the teeth. They should be drawn out as gently as possible without biting or breaking. With older lambs

the operation is performed in a similar manner, but the cords are scraped through with a knife. The scraping is done to prevent excessive bleeding. Wash the quarters and around the cuts with a good solution of disinfectant. If possible, avoid allowing this to enter the wound, as its presence tends to delay healing. The operation is best performed in the morning so that lambs may be watched during the day and attention given to any that become weak through loss of blood.

Occasionally one testicle does not pass down to the scrotum as soon as the other and the operator may only be able to remove one at marking time. Such a lamb is commonly known as a "rig." The tail should be left on to distinguish it and the animal killed as early as possible.

An alternative method of castration has come into prominence in recent years. With it the spermatic cord is crushed and severed by means of powerful blunt pincers, but without any external wound. The testes do not develop and thus fail to function for reproductive purposes. Advocates claim that this (the Burdizzo method) is faster and advantageous because of no loss of blood, but it may be criticised because of its element of uncertainty. Imperfect manipulations may easily result in one or both cords being imperfectly crushed or missed altogether.

Experiments using both Burdizzo and knife methods conducted recently at the Merredin Research Station showed no apparent difference in mortality, growth rate, or in quality of carcase.

The tailing operation is comparatively simple. The tail should be seized in one hand and cut off at the second joint from the rump. The joint can easily be found by pressing the tail between the thumb and forefinger. Care should be taken that the skin is not stretched towards the tip of the tail, as an unsightly stump of tail will be shown after the cut. It is advantageous to push the skin towards the root of the tail before severing. This will lead to quicker and better healing. Swab the tail and quarters with a disinfectant solution. If the severed blood vessels bleed too freely, a ligature should be tied tightly around the stump. This may be removed as soon as the blood clots and seals the vessels.

It has been claimed that the "searing iron" method of detailing not only prevents loss of blood but minimises the danger of tetanus. The tail is seared off by means of a chisel at cherry red heat. Not only does this method inflict greater pain and shock on the animal, but it is more troublesome to the operator and the wounds take longer to heal. The bone is generally crushed instead of being cut off clean at the joint, as it is with the knife method. It is doubtful whether the claim re unlikelihood of tetanus infection is justified. Tetanus is an anaerobe and the seared tail would create ideal conditions for the bacteria to breed in. Numerous cases of death from tetanus after searing the tail have been reported and I have no hesitation in condemning the practice. With free bleeding any pathogens present are likely to be washed out.

After the operations have been completed, the lamb should be lowered gently on all four legs. Mother all lambs and examine occasionally to see that the cuts have not been flyblown.

LITERATURE CITED.

1. "The Searing Iron v. The Knife for Detailing Lambs." J. Wrenford Mathews.
2. "Castration Experiment—A Comparison of the 'Burdizzo' and Knife Methods." F. L. Shier and N. Davenport in "W.A. Journal of Agriculture," June, 1936.

TOXIC PARALYSIS IN SHEEP.

PREVENTIVE INOCULATION.

The attention of sheepowners, who are desirous of obtaining vaccine for the inoculation of their sheep against toxic paralysis prior to the coming of summer, is drawn to the fact that the Department of Agriculture intends obtaining supplies of the vaccine for distribution from the Commonwealth Serum Laboratories. The preparation of this vaccine takes some three months and for that reason orders must be placed immediately. Persons desiring supplies are, therefore, requested to submit their applications as soon as possible so that early delivery may be arranged. The vaccine will cost 12s. 6d. per 100 sheep and it will be necessary to have the first inoculation completed during the month of August in order to ensure a maximum of benefit through such inoculation. The procedure is to inject 1 c.c. of the vaccine and follow on with a second inoculation of 5 c.c. eight weeks later. Any person who has not done the inoculation can arrange with the Chief Veterinary Surgeon, Department of Agriculture, Perth, to be instructed in the method of doing this work. Advice will be given in respect to the type of hypodermic syringe required.

Applications, together with the amount to cover the cost of the vaccine, should be forwarded to the Chief Veterinary Surgeon, Department of Agriculture, Perth, as soon as possible in order to ensure that supplies will be made available.

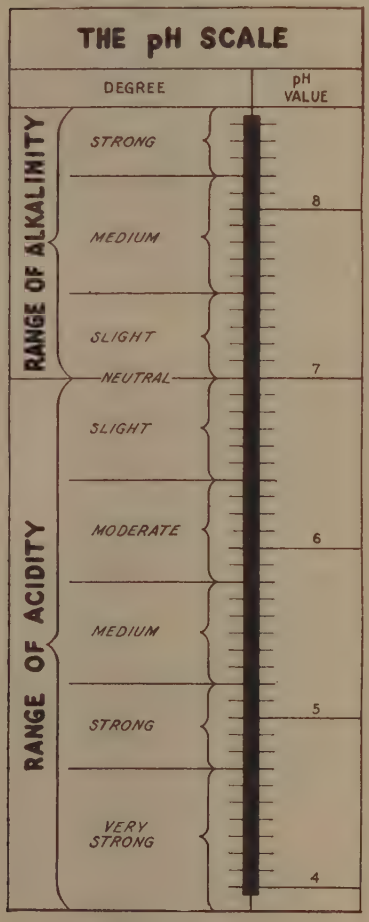
AGRICULTURAL PROBLEMS.

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

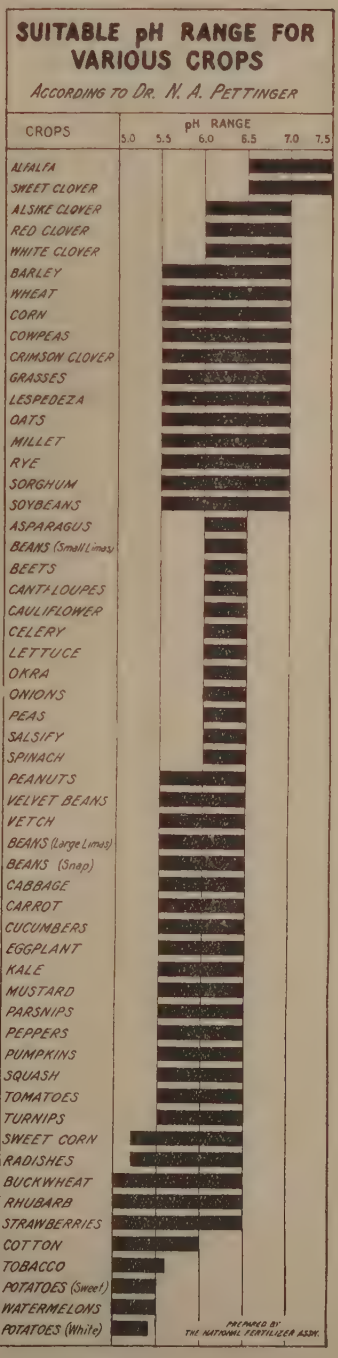
The addresses and name of Advisers are as follows:—

Albany	**A. C. Vaughan.**
Bridgetown	**A. Flintoff.**
Bunbury	**M. Cullity.**
Denmark	**V. L. Cardon.**
Geraldton	**G. L. Throssell (Government Buildings).**
Gosnells	**R. C. Owen.**
Harvey	**D. L. Breen (Fruit); C. Giles (Dairying).**
Katanning	**A. S. Wild**
Kalamunda-Roleystone	**W. H. Read, c/o. Department of Agriculture, Perth.**
Manjimup	**K. W. Simes.**
Metropolitan, Gingin, Chittering ...	**S. E. Bennett, c/o. Department of Agriculture, Perth.**
Metropolitan to Spearwood ...	**R. L. Cailes, c/o. Department of Agriculture, Perth.**
Mundaring	**V. Cahill.**
Narrogin	**H. R. Powell.**
Northam	**F. L. Shier.**
Northcliffe	**H. S. Rogers.**
Vasse	**J. M. Nelson.**



THE pH SCALE.

Farmers are constantly meeting references to the term pH in quoting the degree of soil acidity, or, to use a better term, soil reaction. In the pH scale, pH 7 is called *neutral,* that is, neither acid nor alkaline; higher pH values are termed *alkaline,* and lower, *acid.* In the diagram, reproduced from "Superphosphate," Vol. X., Jan., 1937, the pH scale is represented in the form of a thermometer, and the ranges of soil reaction, or pH value, in which 56 crops appear to thrive best, are given.



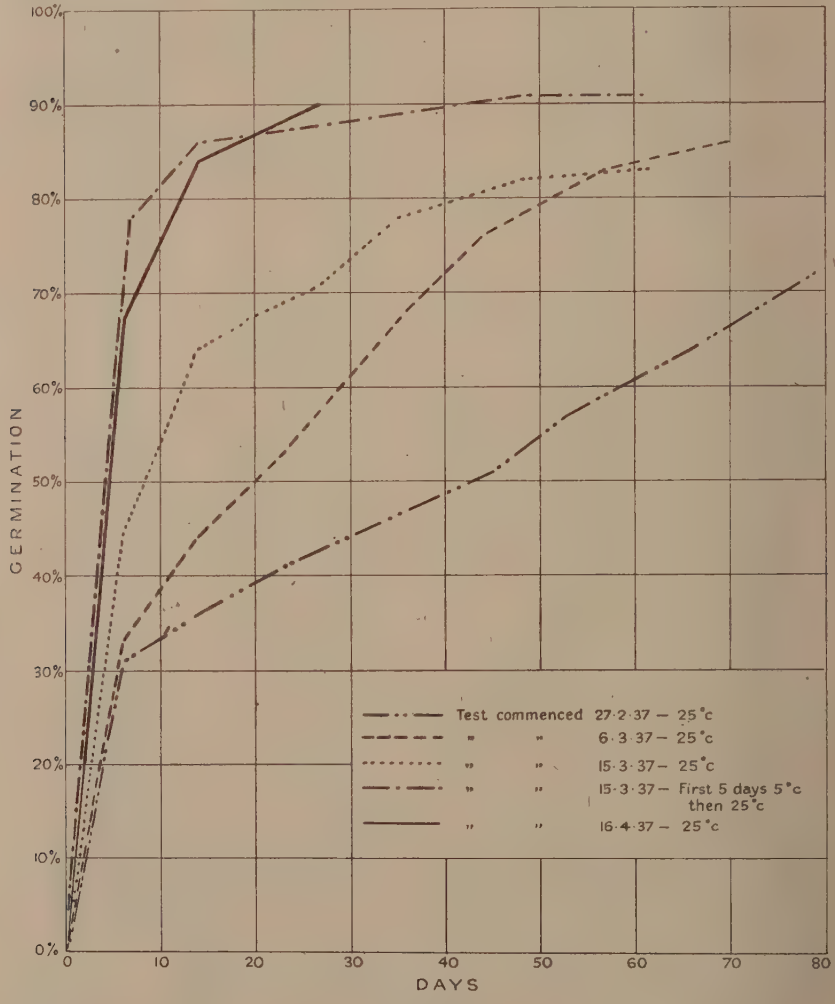
From "Superphosphate," Vol. X., No. 1, January, 1937.

WIMMERA RYE GRASS.

DELAYED SEED GERMINATION.

G. R. W. MEADLY, Acting Government Botanist.

Difficulty has been experienced in securing satisfactory germination figures for newly harvested Wimmera Rye grass seed, particularly seed of Victorian origin. At the standard temperatures of 20°C. or 25°C. with filter paper substratum, at times only 5 per cent. germination has been secured in six days, increasing to 40 per cent. in 14 days. Some improvement was experienced by using a substratum of sterilised soil, but the total potential germination was not secured under these conditions during the standard period of testing. ("W.A. Journal of Agriculture," June, 1936.)



GRAPH.

Showing germination of Wimmera Rye grass seed at different temperatures and periods after harvesting.

Drying the seed for several days at 40° C. did not improve the results, but conducting the first five days of the test at 5° C., followed by nine days at 25° C. has given most satisfactory results. The following table provides comparative figures for three samples tested during the present season:—

	No. 3011.	No. 3012.	No. 3016.
Test commenced 27-2-37	31%— 6 days	10%— 6 days	...
	36%—14 days	34%—14 days	...
,, ,, 6-3-37	33%— 6 days	16%— 6 days	...
	44%—14 days	43%—14 days	...
.. .. 15-3-37	44%— 6 days	21%— 6 days	34%— 6 days
	64%—14 days	51%—14 days	64%—14 days
,, ,, *15-3-37	78%— 7 days	85%— 7 days	86%— 7 days
	86%—14 days	87%—14 days	91%—14 days
,, ,, 16-4-37	67%— 6 days	60%— 6 days	74%— 6 days
	84%—14 days	88%—14 days	84%—14 days
.. 30-4-37	93%—14 days	94%—14 days	89%—14 days

* First five days of test at 5°C.—followed by a steady 25°C. All the other tests were at 25°C. from the commencement.

By reference to the table it may be seen that, within the margin of experimental error, the germination following the chilling process was the same as that secured by the standard method at about the normal time of sowing.

Wimmera Rye grass seed grown and harvested under certain conditions —apparently related to moisture and maturity—requires an appreciable after-harvesting ripening period before a satisfactory germination may be secured. If the seed, under germinating conditions is subjected to several days' chilling at approximately 5° C., the potential germination may be ascertained probably several months prior to when testing by standard methods or under field conditions. Purchasing seed without having knowledge concerning its germinating capacity is a most unsatisfactory and frequently very costly practice. Results secured by the technique as outlined above are, therefore, of considerable value to seed merchant and farmer alike, as they will allow early sales to be made on a sound basis.

My thanks are due to the Chief Draughtsman, Lands Department, who compiled the graph associated with this article.

M. T. PADBURY TROPHY COMPETITION.

I. Thomas,
Superintendent of Wheat Farming.

A further year's results are available for the above competition, which has now been conducted for a period of seven years, viz., 1930-1936 inclusive.

This competition was inaugurated in 1930 as the result of a generous donation made by Mr. M. T. Padbury, a pioneer farmer of the Moora district, and will cover a period of ten years, i.e., the final year will be in 1939.

The trophy is a handsome shield, and each year a replica is made and presented to the winner for that year. This minor trophy was won for the past season by Mr. F. C. West, of Toompup, who obtained the average of 2 bushels 56 lbs. per inch of rainfall over an area of 201 acres.

The conditions under which this competition is conducted are as follow:—

1. The competition will commence with the 1930-31 harvest and continue for a period of 10 years. At the end of that period the trophy will be awarded to the competitor who has taken part in the competition for at least five years, and who obtains the greatest mean average acre yield per inch of rainfall during the conventional growing period. The mean average yield will be computed from

the results of the five seasons in which the competitor produced the highest acre-yield per inch of rainfall during the growing period. In the event of a tie the competition will continue between the leading competitors until an advantage is gained by one of them.

2. The conventional growing period for any year will be that decided upon and announced by the Royal Agricultural Society. For the first year, and until further notice, it was decided that it would be from 1st May to 31st October, inclusive.

3. Until the end of the competition the trophy will be in the custody of the Royal Agricultural Society, and will be displayed at any agricultural exhibition held by that society.

4. Each year the competitor who obtains the best average acre yield per inch of rainfall during the conventional growing period will be awarded a replica of the trophy. His name will also be inscribed upon a small shield affixed to the trophy.

5. The rainfall upon which the award will be made will be determined by the Commonwealth Meteorologist from the district records, and his decision in this matter will be final.

6. The competition will be limited to those farmers who harvest at least 200 acres of wheat for grain. Where a competitor is financially interested in the crops grown on one or more farms, he will be required to supply details regarding the production and marketing of the crops on same, and, though usually the award will be made upon the results from the farm nominated by the competitor, the Royal Agricultural Society may require that the crops on these farms be included in the competing area.

7. The average yield will be ascertained from the total area—including self-sown crops—harvested for grain, and determined from the actual amount of wheat sold, as shown by the delivery dockets, plus the amount retained for seed, for home use or for any other purpose.

8. The method of judging will be as follows:—At a convenient time the area harvested for grain will be measured and the quantity of wheat on hand ascertained. On or before 31st January the farmer will be required to furnish the judge with a sworn declaration as to the quantity of wheat sold from the competing holding or holdings, and the amount retained for seed and other purposes; the statement regarding the amount sold to be supported by agent's dockets. The judge, after satisfying himself as to the correctness of this statement, will compute the average yield per acre per inch of rainfall during the growing period from the information received.

9. The judge will be appointed by the Director of Agriculture, and his decision will be final.

10. Nominations for this competition will be received by the Royal Agricultural Society up to the 31st October each year.

The results for 1936 are as follows:—

Competitor.	Address.	Rainfall during Growing Period.	Area Harvested.	Yield.					
				Gross.		Average per acre.		Average per lin. Growing Period Rain.	
		points.	acres.	bus.	lbs.	bus.	lbs.	bus.	lbs.
F. C. West	Toompup ...	986	201	5,804	51	28	52	2	56
J. Deane Hammond	Kellerberrin	595	340	4,939	30	14	32	2	27
D. F. Barr	Shackleton ...	924	401·5	7,040	12	17	32	1	54
J. R. Bremner & Son	Corrigin ...	986	760	13,569	36	17	51	1	49
P. A. Strange ...	Yarding ...	787	277	5,343	46	14	10	1	48
N. A. Scadding ...	Kulin ...	897	474	6,704	41	14	8	1	35
R. T. Best	Koorda ...	690	429	3,242	54	7	34	1	6

REFURNISHING OF FRUIT TREES.

V. CAHILL,
Horticultural Instructor.

The following notes have been compiled for the use of readers of this Journal in response to requests for a description of the method used when re-working apple, pear and plum trees.

The re-working of an unsuitable tree to a profitable variety is one of the most important problems confronting the fruitgrower. The old method of cutting the tree hard back and grafting has been superseded by the new system of refurnishing. The old method caused a loss of several years' fruiting and frequently induced destructive fungus diseases, as seen in Figure 1, which in many cases are followed by white ants. Waiting from six to seven years before the tree comes into profitable bearing is far too long, and life is too short to wait that length of time. Refurnishing is the term adopted for this new method and aptly describes the system.

The initial work is carried out in the winter when the trees to be treated are as shown in Figure 2. The main limbs are slightly reduced in length, all laterals

Figure 1.
The Old Grafting Method. The grafts affected by *Schizophyllum commune*.

Figure 2.
Apple tree before being stripped of its laterals and fruit spurs.

and fruit spurs being taken off, leaving only a bare skeleton framework Figure 3. By this method large wounds which are apt to provide an entrance for fungal organisms and the formation of a large area of dead wood tissue are avoided. Should any large wounds be caused by the operation they should be coated with a fungicidal paint or Bordeaux Paste. During the following spring the trees will force a large number of new growths throughout the

Figure 3.

Apple tree after being stripped of its laterals and fruit spurs.

Figure 4.

Apple tree with the laterals thinned out ready for budding. *Jan. 1935.*

length of the main limbs. The best of these are selected at the desired distance of about eight inches apart, and all other growths removed when they are soft and immature. Figure 4.

Budding may be commenced in January or as soon as the new growths are sufficiently mature to allow the buds to be inserted. Buds ready for insertion are shown in Figure 5. When inserting the buds place them as near to the main limbs as possible (Figure 6), at the same time choosing the best positions for converting the resultant growths of the new variety into sub-limbs, laterals and fruit spurs.*

* A proper budding knife with a keen edge should be used in carrying out this operation.

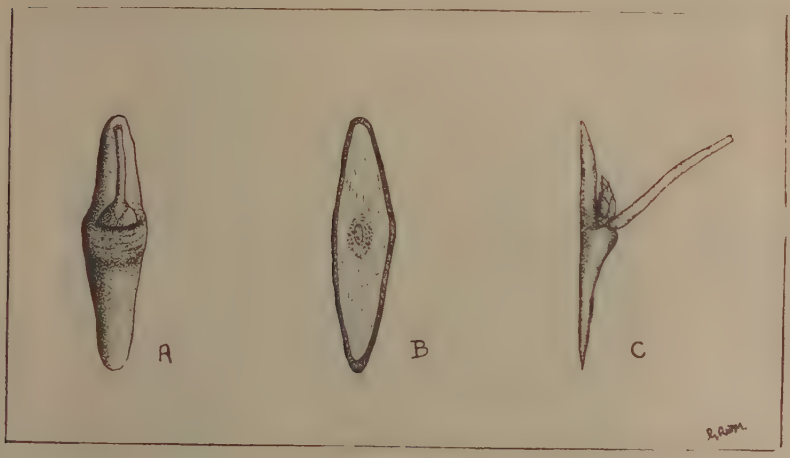


Figure 5.
A.—Front view of bud. B.—Back view of bud. C.—Side view of bud.

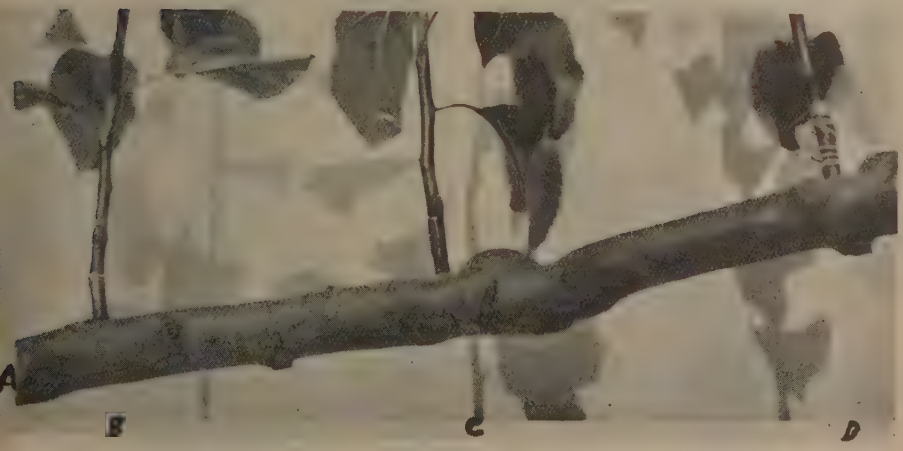


Figure 6.
A.—Limb showing laterals. B.—"T" shape cut in the bark of lateral, to receive the bud. C.—Bud inserted. D.—Bud tied into position.

The buds should remain dormant during the autumn and winter months, and the growths pruned back to the buds just before the sap commences to rise, as shown in Figure 7 where the buds have started to grow. If "misses" occur it is advisable to leave these growths uncut and work them over, using the whip or tongue method of grafting as shown in Figure 8.

Although the new method is slow, the returns are quicker and the actual results infinitely better as indicated in Figure 9, which shows the crop two years after budding. The successful "bud take" has a strong fusion with resultant growth: therefore, the branch of the new variety is able to bear a substantial crop without fracture. Figure 10.

Figure 7.
Apple tree with the laterals cut back to the inserted bud, and showing the spring growth of the new variety. *Nov., 1935.*

Figure 8.
Whip or Tongue Grafting.
A.—Stock and scion prepared. B.—Parts fitted together. C.—Wrapped with light twine and ready to wax over.

The writer has personally carried out side bark grafting and plug grafting, besides budding and tongue grafting. The former two methods resulted in a large percentage of "misses" and it is problematical how much the tree will be affected by the numerous wounds, and many fractures which will occur when the remaining grafts come into bearing. With the latter two—budding and tongue grafting—no fractures from the main stem have been experienced when carrying a heavy crop on the resultant laterals. Care should be taken that all adventitious growth be suppressed after refurnishing a tree so that the new variety may predominate.

Figure 9.—Same tree as shown in Fig. 7 bearing a crop of apples. *March, 1937.*

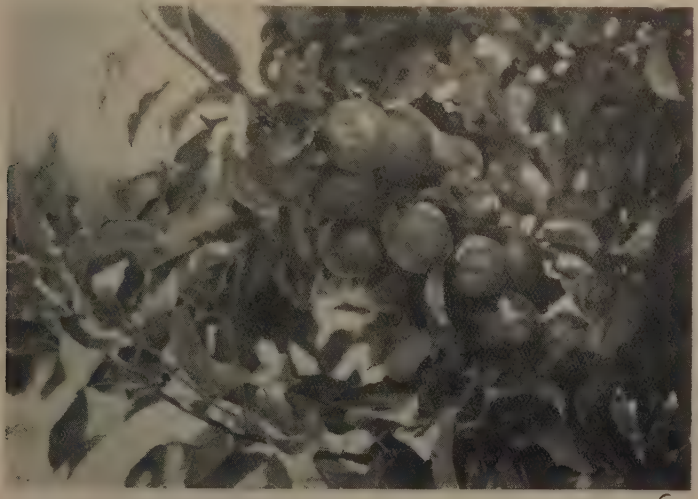


Figure 10.—Limb of tree carrying fruit two years after budding.

BACON CURING ON THE FARM.

By G. K. BARON-HAY.

It is not proposed to deal here with the methods and appliances employed in the curing of bacon on a large scale, but to endeavour to explain the principles and methods applicable to the curing of bacon by individual farmers or householders.

PIGS SUITABLE FOR BACON.

It is essential that pigs for slaughter should be in perfect health. Fortunately the incidence of the two most common diseases amongst pigs, namely, tuberculosis and swine plague, is extremely low. The latter can be easily recognised by external symptoms and the pig exhibits obvious signs of disease. Tuberculosis, however, may be present although not detectable in the live pig, but a useful rule is never to kill an animal for consumption that is losing weight.

Pigs should not be driven hard or excited prior to slaughter, as the flesh is toughened and may not cure satisfactorily.

The best class of bacon is obtained only from young pigs, ranging from 6 to 8 months old, weighing from 140 to 180 lbs. live weight, equal to 105 to 135 dead weight.

SLAUGHTERING.

Farm bacon should be made during the cool months of the year, temperatures higher than 60deg. F. during the day being undesirable. These conditions are found usually from June to September in Western Australia generally, but until November in the South-West coastal areas.

Before slaughtering pigs should be quietly driven into a pen and starved for 24-36 hours, but should have access to plenty of clean water.

The pig should be stunned by a smart blow with a long-handled hammer or back of an axe. The pig is then held on its back or hung by a rear leg and stuck, by inserting a long knife in the throat immediately in front of the breast bone, with the point towards the tail, and firmly forcing in line with the backbone for 6-8 inches. The blade is then turned completely round and withdrawn. This severs the arteries on both sides, near the windpipe, the blood spurting out.

It is essential that bleeding should be completed, and struggling assists in this object; the pig, however, being unconscious, feels no pain.

SCALDING.

A tub or wooden vat is desirable in which the whole pig can be immersed, but if this is impossible, scalding water may be poured over portions of the pig, these being scraped immediately. The job, under these circumstances, is a tedious one.

The temperature of the water should be from 165-175deg. Fah. It is desirable to use a thermometer to ascertain the temperature of the scalding water, as too hot or too cold will not loosen the bristles.

If wholly immersed, the carcase should be kept moving in order to obtain an even colour of the skin and avoid reddened patches after scraping. After soaking for several minutes, and the hair by test is found to be readily detached, scraping may be proceeded with. In factories scraping is carried out in the tub, but on farms it is preferable to lay on a suitable bench, a convenient form being that of a grid placed over the vat. When scraping, start with the head and feet. See that the nose, ears, and feet are made sweet and clean. Finally wash down and remove patches of remaining hairs and scurf with a sharp knife. Should the

hair not scrape off easily in certain areas, further applications of hot water should be made. The toenails can be easily pulled off by inserting a hook just above the hoof.

The carcase should finally be washed with clean cold water, and hung by inserting a gambrel through each hock.

CUTTING AND CLEANING.

With a sharp knife cut around the tail and back passage to release from the surrounding tissue. The ventral surface should then be cut through from the tail, along the centre of the belly to the jaw, taking care not to cut any of the internal organs. The breast bone should be cut or sawn through. Grasp the intestines just below the bladder, releasing the back passage if necessary, drawing them forwards and downwards, which will expose the kidneys attached to the backbone.

By cutting at the rear of the cavity just under the kidneys and then around the diaphragm or partition retaining the intestines, the whole of the entrails can be pulled forward out of the carcase, including the intestines, spleen, liver, stomach, heart and lungs, cutting down along the gullet and windpipe to the tongue.

A spreader 9in.-12in. long should be inserted in the flanks to keep the carcase open for cooling, washing and draining. The jaws may similarly be opened by a piece of pointed stick about 6-8in. long.

The carcase is well washed with clean cold water, rough edges trimmed off, and hung to cool and dry in a dust-free, clean atmosphere for 24 hours.

CUTTING UP.

When the carcase is firm and set, cutting up may be carried out—either while hanging or on a table. The head and trotters are first removed, the former by cutting all round the neck deeply, just behind the ears, force being applied to screw the head off the spinal column.

A deep cut should now be made through the back skin and flesh close to the backbone, right from the tail to the end of the neck. The ribs are then sawn from each side of the backbone. If these operations have been carried out with the carcase hanging, the sides are now placed flat on a table or bench with the insides exposed.

The mesentery or leaf lard can now be removed, commencing near the flank, taking away the kidneys with the lard fat.

Trim the sides all round, removing rough edges of bone, blood and stained pieces. If it be intended to cure the complete side, no further dressing or cutting is required.

The ham may be removed if desired, however, by cutting in a slightly circular shape, commencing at the flank, detaching it from the middle piece or flitch.

The shoulder can be removed by cutting through the side between the fourth and fifth rib.

BACON CURING.

This should be conducted only during the cooler months of the year, as it is important that as constant a temperature as possible should prevail and that this should not exceed 60deg. F. Lower temperatures and a humid atmosphere are preferable, but these cannot always be obtained on farms, large establishments working at temperatures varying from 40deg.-50deg. Fah.

A cellar makes a good curing room, being cool and moist, and the absence of light prevents bleaching of the red meat.

Bacon may be cured either by the dry method or by pickling in various liquids.

MORDANT FOR FIXING THE COLOUR.

Immediately after cutting up and trimming, the surface flesh should be dusted over with equal parts of fine salt and finely ground saltpetre (potassium nitrate). Only a light dusting is required, which should be allowed to remain for 24 hours, and then washed off.

DRY CURING.

Various recipes are in use for a curing mixture, common salt being the main constituent in all. The use of common salt alone has a hardening effect on meat, and also causes the natural flesh colour to fade, lessening the attractiveness of bacon.

To correct the hardening influence of common salt brown sugar is commonly used in varying proportions. It also adds brightness, and increases the juiciness and flavour, the sugar also acting as a mild antiseptic.

Saltpetre is usually added in small quantities to preserve the colour. If too much is added the natural colour of the meat is changed to a deep brown, which turns a grey colour on cooking.

The following recipe is recommended by the Hawkesbury Agricultural College, New South Wales:—

Fine dry dairy salt—50 parts by weight.
Brown sugar—5 parts by weight.
Saltpetre, powdered—2 parts by weight.

The mixture should be stored in the curing room for several days prior to use, so as to be the same temperature as the meat.

For the first three or four days after the colour-fixing mordant has been washed off, the above mixture should be rubbed lightly over the fleshy parts and packed round the bones and joints. After the first 3-4 days, the mixture should be spread freely over the sides every 3-4 days, the sides being stacked, and their position in the stack reversed at each handling. The time required for curing is about 14 days.

PICKLING.

Practically every bacon curer has a private recipe for making the pickle; the following, however, can be recommended:—

Clear rain water—10 gallons.
Fine dry dairy salt—25 lbs.
Brown sugar—2½ lbs.
Saltpetre—1 lb.
Allspice—¼ lb.

The quantities given are sufficient for 250 lbs. of meat.

Dissolve the salt, sugar and saltpetre in the water, and immerse the allspice tied up in a calico bag. Boil for one hour and skim off any frothy matter rising to the surface during boiling. Allow solution to cool before use. The sides should be rubbed with salt for two to three days before being placed in the pickle. The time required to pickle varies with the size of the sides, but is usually about three weeks.

SMOKING.

After dry cleaning or pickling, the sides are brushed, any loose pieces of meat cut off, and the meat placed in a vat of cold water containing bicarbonate of soda (1 lb. to every 20 gallons of water) for 24 hours. Remove and wash in a bath of tepid water (blood heat).

The meat is now hung in a dry clean place, in a draught, if possible, until thoroughly dry. It is most important that the meat shall be perfectly dry before smoking is commenced.

Smoking should be carried out in some device which surrounds the flesh with a dense smoke, but without heat. Jarrah sawdust, with a few green twigs or leaves amongst it makes a cool fire with ample smoke. The temperature should not rise above 90 deg. F., otherwise the fat will melt and run away from the meat.

Smoking may occupy from one to three days, and is stopped when a light brown or tan colour is obtained. The bacon should be allowed to cool down before being handled. The sides may be given a pleasing appearance by rubbing the skin and flesh with pure olive oil.

In order to keep flies and other pests away during storage, the surface may be sprinkled with black pepper or a mixture of black and cayenne pepper.

Reference—Potts, H. W., "Pigs and Their Management."

THE FARM HORSE: HINTS ON FEEDING.

A. McK. CLARK, L.V.Sc.
Chief Inspector of Stock.

The feeding of the farm horse is a matter of great economic importance, as it is intimately connected with the production of disease or the preservation of health. The farmer on the wheat belt is in a very happy position insomuch that he has no infectious or contagious diseases to contend with. Also hand feeding and the cultivation of pastures eliminates the possibility of plant poisons. It should naturally follow that the mortality would be low, but this is not so, as the deaths reach a greater proportion than should be the case. This is attributed, therefore, to insufficient care in the feeding of these animals. It is with the object of minimising this particular wastage that I wish to deal with the general principles involved in correct feeding, so that those who are apt to consider the feeding of the horse as of little consequence as regards its health, may be enlightened. Correct feeding is an art which comes naturally to the horse lover and keen observer, whilst it is never acquired by the person who looks upon this animal as a mere slave.

When looking at this matter from a plain and practical standpoint, one needs only to go into the nutritive values of foodstuffs superficially, and in doing so deal with the rations available and commonly used on the average farm, namely, chaff, bran, oats, green foods, and stubble.

Chaff, bran, and oats, if used correctly, are all that is required to maintain perfect health and produce the energy necessary for the working horse.

Chaff.—This may be wheaten or oaten, cut for the purpose of avoiding waste, blending with the supplementary ration and aiding masticulation. Oaten chaff is the more nourishing of the two. A good sample of chaff is equal to one-third the value of good oats, whilst some inferior samples are only the value of straw. The farmer generally is apt to over-estimate the value of chaff as a ration. It is too bulky a ration to feed solely to working horses. The quantity required to maintain condition and provide the necessary energy is so great that the capacity of the bowels is overtaxed while endeavouring to accommodate such. The stomach is distended, leading to pressure on the diaphragm and consequent interference

with the breathing apparatus. Extra work is also thrown on the digestive system, and retarding of assimilation results. An illustration of this is only too often seen in the pot-bellied, wasted muscle, short-winded, and constitutionally weakened plough horse. This animal is a fit subject for colic, and apart from the risk of loss through death, a loss of power results. These two factors can be obviated by an alteration in diet. Replace a quantity of the chaff by a more concentrated ration, such as oats. If the oats are of good quality, every one pound substituted for every two pounds of chaff would provide an excess of nourishment and a decrease of bulk. At the same time, too great a reduction in the chaff should not be practised, as bulk is essential as an aid to digestion. The alteration of the diet should be based on the principle that the harder the work performed the greater should be the amount of concentrates added. The idle horse can be fed on a fair averaged sample of chaff without risk.

Oats.—Of all grains, oats represent one which is essentially a horse food, on account of its being easily digestible and its constituents being so evenly balanced. A good oat should be short and plump. Oats are fed bruised or whole. While the former are best for horses which are debilitated or have defective teeth, crushing is not necessary, as digestion is not aided by this in the normal horse. The nutritive value of the best oats as compared with good quality chaff should be regarded for practical purposes as one pound of oats to three pounds of chaff.

Bran.—This consists of two kinds, fine and coarse; the former is termed pollard and the latter bran. Salts are excessive in bran, and the nutritive value is a matter of question. As a health producer it is almost essential where green feed is not available, and for this purpose should be used wherever possible. It is laxative in its effects, and for this purpose, if not given in small quantities for the working horse daily, should be given as a week-end ration; but not more than three pounds should be fed at the one time. As a week-end ration, it may be given with advantage as a mash. Where dry hay or stubble is the main diet for the spelling horse, it should be supplied at least once a day with a little chaff and bran.

Stubble.—The practice of turning the horse out on stubble when harvesting is completed, without a supplementary ration, often leads to disastrous results. This diet, owing to its dry fibrous character, brings about a loss of tone in the muscular wall of the bowels, and they become inactive. Sand, which is taken up in the pastures, is not expelled, nor are parasites, which are common in the horse. The supply of bran, at least once a day, in this case will maintain the normal condition of the bowels, and also produce that laxative effect which is required to expel the greater proportion of sand and worms.

Green Food.—This should always be supplied in small quantities, when available, to the working horse, and may replace bran; whilst the idle horse is maintained solely on grasses which, when matured, are a perfect health restorer.

The Combined Ration.—The daily ration for a working farm horse should be approximately 15lbs. chaff, 10lbs. oats, and 2lbs. bran. In the case of idle horses the oats may be withdrawn altogether and replaced with increased quantity of chaff. The art of successful rationing can only be acquired by close observation. The characteristics of each horse should be closely watched. Some are rapid feeders, whilst some are slow. Some are large eaters, while some eat little. All these things should be taken into consideration, and measures adopted to create conditions as near normal as possible. Those that require more food should be given it, and those which are slow eaters should be given longer time to eat it. Rapid eaters should be prevented from bolting their food by placing

a few stones in the mangers. In order to control those conditions, horses should be fed separately. The horse has comparatively a small stomach, and one which is easily distended if over fed. For this reason they should not be allowed to go for too long an interval between feeding. The practice to adopt always is to give small feeds and often, and one which will be completely eaten up at each meal. Under normal conditions feeding should be carried out at regular intervals, such as 6 a.m., 12 noon, 5 p.m., and 10 p.m. Do not work a horse immediately after a meal, but allow him ample time to digest a portion of it. A change of diet always requires careful attention. Colic very often supervenes when horses are brought in from pastures and suddenly changed on to hard working diet. For this reason the change should be made gradually, by giving small feeds to commence with. A safe procedure to adopt is to bran-mash the animals for the first couple of days immediately following their return to the stables. Do not put horses to work for at least four days after the change of diet takes place.

Watering.—Pure water is just as necessary for stock as it is for man. For this reason well water supplied out of troughs or a running stream is always best. Dam water which has become polluted is dangerous, as it harbours parasitic infection. Horses are particularly prone to parasitic infection. Wherever possible dams should be fenced in and provided with a mill and trough. Always water before feeding. This should be observed on account of the small stomach of the horse, for if watered after feeding the flush of water will remove undigested food to the more delicate portions of the intestines, where it will cause irritation of those parts, and subsequent colic. When working, no harm is done in watering horses whenever possible. This will prevent the sudden ingestion of a large quantity of cold water, and resulting chills and colic.

TOBACCO SEED-BED MANAGEMENT.

A. SHARP, U.D.A., Tobacco Adviser.

INTRODUCTORY.

The provision of an adequate supply of well grown healthy seedlings from about the end of September onwards is one of the most important factors in successful production of tobacco leaf. The early part of October is the ideal time for planting out seedlings in the field in the Manjimup district. By that time, most of the cold weather is over and the ground has warmed up sufficiently to permit of fairly rapid growth, while in normal season sufficient rain may still be expected to enable the plants to make good growth before the hot dry summer weather sets in. It is true that in a few favoured situations on well sheltered, moist land late planting has been quite successful, but there is no doubt that, for the average tobacco grower, early October planting is the ideal to aim at.

Unfortunately, the cold, wet weather usually experienced in the Manjimup district during the early spring makes the provision of transplantable seedlings at this time almost impossible unless precautions are taken to protect seed-beds from the ill effects of cold weather, frost, excessive rain and disease. Formerly it was a common practice to plant fairly large areas of seed-beds in the open, and to leave them to take their chance, in the hope that, although some of them were almost sure to be a failure, sufficient would survive to plant the area required. It is now generally admitted by tobacco growers that this is not a good method.

A number of growers have adopted the practice of having their seedlings grown for them in districts where the weather is milder than at Manjimup, the metropolitan area being popular for this purpose. While seedlings can be raised in the open there earlier than farther south, the practice is open to certain objections, the most important of which is the risk of importing disease into the tobacco-growing districts. For instance, it is well known that eelworm (*Caconema radicicola*) is widely distributed in the soils around Perth. This nematode is a serious pest of tobacco in the Eastern States, and in Queensland it is recognised as one of the principal causes of low yields of leaf. Until the 1936-37 season, eelworm was unknown in the Manjimup district, when unfortunately it made its appearance in a small portion of one tobacco crop. It may be regarded as inevitable that continued importation of large quantities of tobacco seedlings from the infected soils of the metropolitan area will lead before very long to the widespread appearance of this pest in the South-West. The careful grower, therefore, will do his utmost to produce sufficient seedlings for his requirements on his own farm, even at some expense, rather than run the risk of introducing disease from outside.

The alarming increase of the dreaded seed-bed disease Downy Mildew, generally known as "Blue Mould," has rendered the necessity for the most careful seed-bed management more imperative than ever. The only effective method evolved so far for controlling this disease is by the use of benzol in covered seed-beds, as explained in Leaflet No. 486 issued by the Department, and it is fortunate that the covering necessary for this treatment fulfils also the purpose of protecting the seedlings from cold, wet weather, frost, and to some extent at least, from insect attack, and stimulates the plants to more rapid growth, thus permitting earlier planting out than is possible with open seed-beds.

AREA OF SEED-BED REQUIRED.

The first question to be decided by the grower is the area of seed-bed he will have to sow. It is possible to grow up to 1,000 vigorous tobacco seedlings per square yard of seed-bed. If more than this number be permitted to grow, they tend to become spindly and weak. A reasonably successful seed-bed should carry an average of at least 700 plants per square yard. The number of seedlings required per acre varies from about 5,000 to 7,000 according to spacing. It will be seen, therefore, that ten square yards of seed-bed should yield at least sufficient seedlings to plant one acre, but it is usual to allow a margin over this in case any replanting may be necessary owing to insect attack in the field, etc. Twelve square yards of seed-bed for each acre to be planted may be taken as the safe minimum.

SELECTION AND PREPARATION OF SEED-BED SITE.

The seed-bed should preferably be established on rich, well-drained sandy soil. Although very rich soil is not suitable for the tobacco crop in the field, the most rapid and vigorous seedling growth is obtained in rich, heavily manured soil, and there is no danger of such soil in the seed-bed affecting the quality of the leaf from the mature plant. Heavy soils are not suitable, as these tend to form a crust on the surface which is detrimental to seedling growth.

The site should be open to the east and north so as to allow the maximum of sunlight to gain access to the beds, but it should be sheltered from the south and west.

The site should be selected in autumn, and dug over or ploughed thoroughly in May, after the weed seeds have germinated, and be kept entirely free from weed growth throughout the winter. A sufficient area should be turned over to permit

of at least five or six yards of cultivated soil all round the seed-beds. The advantages of thus fallowing the soil for a month or two before sowing are that the soil is sweetened, weed growth is killed, and any pests in the soil, such as red-legged earth mite, are starved out. The strip of bare soil round the beds serves to protect them from invasion by red mite, etc., from surrounding areas.

CONSTRUCTION OF SEED-BEDS.

The construction of the beds should begin early in July. They may be made any convenient width, say from three feet to four feet six inches, and any length according to requirements. If very long beds are constructed, however, it is recommended that they be partitioned off in lengths of about 30 to 40 feet in order to avoid the risk of currents of air dispersing the benzol fumes to be used later for the control of Downy Mildew.

The frame surrounding the seed-bed should be made of jarrah boards. Face-cuts, which are obtainable cheaply from the saw mills, are quite suitable. Bush timber is not very satisfactory for the purpose.

There are several alternative designs which may be used. Probably the best one—which is also the most expensive—is to construct a wooden frame 18 inches high along the back of the bed and nine inches high along the front, with sloping ends. Wooden sashes are then made to fit closely over the top. These are made of 2in. x 1in. timber, and may be up to ten feet or so in length. They may be made entirely removable, or, preferably, hinged at the back, so that they can be propped open during fine days. The covering material is tacked on to these sashes. Figure 1 is a sketch of this type, showing one sash open and part of another closed. This

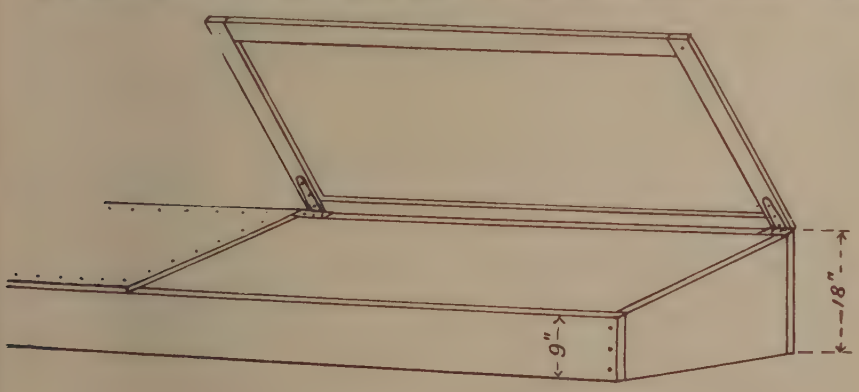


FIG 1

type of frame can be covered by simply fixing wooden bearers every three or four feet along it, and stretching a calico cover over these and tying it down with tapes. To uncover, the tapes along the front and ends are untied and the calico rolled up.

Another type, which requires rather less timber, consists of a wooden frame, 6 to 9 inches high, all round the bed. A length of fencing wire is stretched tightly along the centre line of the bed, supported every ten feet or so by a short post. This wire should be nine inches to one foot higher than the top edge of the frame. The calico cover is tacked down along one side of the frame and is brought over the wire and tied down to the other side. The ends are filled in with shaped timber. When closed, this type has the appearance of a rather flat-roofed tent.

The principal advantage of the first type described is that the sashes can be easily and quickly handled when opening and closing the beds, and the covering is never rolled up and is therefore less liable to discolouration.

COVERS.

A number of different types of cover have been tried out experimentally at Manjimup. So far, the most satisfactory one, which is not unduly expensive, is unbleached calico treated with a waterproofing solution of paraffin wax, petroleum jelly and mineral turpentine. A fairly cheap quality English calico is quite satisfactory, but the very cheap Japanese calico should be avoided as it is not strong enough to stand up to stormy weather.

A waterproofing formula which has given good results is as follows:—

12 lbs. 125deg.-130deg. paraffin wax.
1 lb. clear petroleum jelly.
1 pint boiled linseed oil.
2 to 3 gallons mineral turpentine.

For a fairly closely woven calico, use about 3 gallons of mineral turpentine. For a very cheap calico, the proportion of turpentine should be reduced to 2 gallons.

The method of making up the solution and applying to the calico is as follows:

The paraffin wax, which is sold in slabs, should be broken up into small pieces and placed in a metal container, with the petroleum jelly, and heated gently over a small fire until it has melted. Care should be taken not to overheat. When melted, add the linseed oil and mineral turpentine slowly while stirring the mixture. The calico should then be drawn slowly through the hot mixture so as to completely saturate it, then pulled through the hands or squeezed between rollers to remove any surplus mixture, and hung up to dry. Where small covers are being dealt with, half the above quantity made up in a 4-gallon kerosense tin, preferably cut lengthwise, can be used as a container. Where, however, covers exceeding, say, 20 feet by 3 feet are to be dealt with, it will be necessary to use a larger container. A shallow trough made of galvanised sheet iron, with a capacity of about 8 gallons is recommended. The mixture must be kept hot while dipping the calico as it sets solid on cooling. If overheated, however, it is liable to catch fire, and it is advisable to have a wet bag handy to smother the flames should this occur. In practice, the process is not so difficult as might be thought, and is much preferable to applying the mixture with a brush. The amount of mixture required will vary according to the quality of calico used, but, with a fairly good quality material, the above amount will be sufficient for about 60 square yards.

Calico so treated tends to shrink, and an allowance of about one yard in thirty should be made if it is cut to size before dipping. A newly dipped cover should not be placed over growing seedlings until it is thoroughly dry, as the fumes of the evaporating turpentine are fatal to the plants.

The cost of treating calico with this mixture works out at about 2½d. per square yard for material at the prices ruling at Manjimup for small quantities.

SOIL PREPARATION.

Having constructed the frame, the soil is worked to a fine tilth, and a complete fertiliser, at the rate of about one pound to the square yard, thoroughly worked into the top three or four inches. Potato Manure "E" or Standard Tobacco Fer-

tiliser each contain nitrogen, phosphoric acid and potash, and are suitable for the purpose. The surface of the soil is then carefully levelled. It should be several inches above the level of the surrounding soil to ensure good drainage.

SOWING THE SEED.

An ounce of tobacco seed contains approximately 300,000 seeds, and in the case of good seed, will be sufficient for at least 100 square yards of seed-bed. It would be extremely difficult to distribute such small seed evenly without using a suitable medium, and the usual practice is to mix it thoroughly with sifted wood ashes, fine, sifted sand or fertiliser. If the last-named is used, it should be sown immediately after mixing, as the fertiliser is liable to injure the seed. A method which the writer has used successfully is to thoroughly mix one level teaspoonful of seed with about one pint of wood ashes, and to distribute the mixture over ten square yards of seed-bed. The ashes show clearly where distribution has been effected.

Having sown the seed, the soil is compacted by means of a light roller or by pressing with a piece of board in order to bring the seed into intimate contact with the soil particles. The seed should not be raked in as this would cover it to too great a depth. It is advisable to give the bed a light watering immediately after sowing. This should be done with a watering can fitted with a very fine rose, otherwise there may be a tendency to wash the seed off the bed. Great care must be taken not to allow the surface of the seed-bed to become dry until germination has taken place. This can be expected in about three or four weeks in the case of July sowing. During very cold weather, the writer has hastened germination somewhat by watering daily with slightly warmed water. It is suggested that successive sowings at intervals of a week or more be made so as to ensure a continuous supply of seedlings during the transplanting season.

CARE OF SEEDLINGS.

When germination has taken place, the seed-bed covers should be opened on fine days and kept closed during the night, and on cold, wet days. As soon as individual plants are discernible, they should be thinned out if necessary. About one plant per square inch is quite thick enough. Overcrowded seed-beds are most likely to be attacked by various fungal diseases to which tobacco seedlings are susceptible. One of the more important of these is known as "Damping-off." It is caused by any of several fungi which produce a rot in the stem of the seedling near the surface of the soil. Quite frequently growers have reported that although their tobacco seed germinated well the seedlings simply disappeared shortly after germination. In all probability this was due in many cases to damping-off. Where seedlings begin to die off in patches, the grower is recommended to apply Cheshunt mixture immediately.

Cheshunt mixture is made by thoroughly mixing together two parts by weight of powdered bluestone and eleven parts by weight of fresh powdered rock ammonia (Ammonium carbonate). The dry mixture is placed in a tightly stoppered glass or stone jar for at least 24 hours before using.

To use, take one ounce of the above mixture and dissolve in two gallons of water in a copper or pitch-lined vessel. Water the affected seed-bed with the solution until the soil is nicely moist, then wash the solution off the leaves of the plants with an amount of pure water equal to the quantity of Cheshunt mixture used. This should be repeated twice a week until the plants are about a month old. In

addition to its action as a fungicide, Cheshunt mixture has been observed to stimulate the growth of seedlings, due, probably, to the rock ammonia acting as a nitrogenous fertiliser.

CONTROL OF DOWNY MILDEW (BLUE MOULD).

Downy mildew is by far the most serious disease affecting tobacco in Australia. It is fully discussed by Mr. H. A. Pittman, Plant Pathologist, in Leaflet No. 486 issued by the Department.

Experience in Western Australia so far has indicated that this disease seldom attacks seedlings less than three weeks old, but from then onwards it is necessary to afford protection by introducing benzol to the seed-beds.

The method adopted by the writer with complete success is to place round 2-ounce tobacco tins at regular intervals along the seed-bed, and to fill these with benzol every evening, just before closing the covers for the night. On opening the covers the following morning, that portion of benzol remaining unevaporated is poured back into the container. During stormy weather, the covers are kept closed day and night, the beds being opened only long enough to replenish the supply of benzol.

The tins for holding the benzol are set up on wire stands about three inches above the surface of the soil, and are spaced so that there is one square inch of evaporating surface to every square foot of seed-bed. Any kind of tin will do, such as tobacco tins, cut-down jam tins, etc., provided, of course, they do not leak. They should not be more than 1½ inches deep, and preferably not more than about 5 inches in diameter.

The following table gives the approximate area of evaporating surface of benzol contained in round tins of given diameters.

Diameter of Tin.	Area of Evaporating Surface.
2 inches.	3 square inches.
2½ „	5 „ „
3 „	7 „ „
3½ „	9½ „ „
4 „	12½ „ „
4½ „	16 „ „
5 „	19½ „ „

From this, the grower can calculate how many tins of given diameter will be required for any seed-bed. For instance, if it is desired to treat a seed-bed 30 feet long by 3ft. 6in. wide, and the tins to be used are 3 inches in diameter, each tin, having a surface area of 7 square inches, will protect 7 square feet of seed-bed. The total area of the bed is (30 × 3½) = 105 sq. ft. Therefore the number of tins required is 105 divided by 7 = 15 tins. The tins should preferably be placed in two rows along the bed, each row about nine inches to a foot from the edge of the bed and the tins staggered as shown in fig. 2.

A concentration up to 50 per cent. greater than that recommended here has been found to be quite harmless to tobacco seedlings, but some injury may be done if such a concentration is exceeded.

A number of substitutes for benzol have been tried out experimentally at Manjimup, but, although some of these have given a fairly high degree of control, none has been entirely successful under all conditions. Growers are therefore recommended to be sure that they use genuine benzol only. It may here be stated

that genuine benzol is defined as being the portion of the light-oil distillate of coal tar with initial and final boiling points at 70 deg. C. and 98 deg. C. respectively, and having a specific gravity of 0.882 at 60 deg. F.

The amount of benzol consumed in the seed-beds will vary somewhat according to weather conditions and the type of seed-bed, but under average conditions a consumption of about one pint per square yard of seed-bed per week may be expected.

Benzol in the liquid state is absolutely fatal to seedlings, therefore it is important to avoid spilling or splashing when filling the tins. It is also highly inflammable and should not be handled near an open flame or lighted cigarette.

While it is advisable to cover seed-beds during stormy weather, care should be taken not to keep covers on unnecessarily, especially within a week or two of transplanting. Seedlings which have been shaded too much tend to become soft and spindly, and do not transplant well. Covers should be closed every night without fail, but should be kept open as much as possible during the day. A few showers will not damage the plants, and the rain on the foliage will not induce an attack of downy mildew, as some growers believe, provided that benzol is used as directed every night.

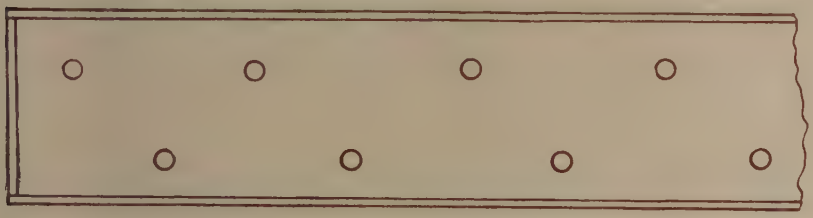


FIG 2

Should the seedlings not be making satisfactory progress, the application of liquid manure may be resorted to. A small handful of nitrate of soda to every four gallons of water may be applied once or twice a week to stimulate growth. It is important not to make the solution stronger than this otherwise the plants may be injured. Better still is an application of a very weak solution of fowl manure, if available.

TRANSPLANTING.

The seedlings are ready for transplanting when about four inches high. Before pulling them, the seed-bed should be thoroughly watered, as the seedlings can be lifted from loose, moist soil with the minimum of damage to the roots. When pulling, the two largest leaves should be held between thumb and forefinger, above the growing tip of the plant. It is important not to injure the stem or growing point, but a little bruising of the outside leaves does not matter as they will be primed off before harvest in any case.

In conclusion, the grower who, by careful management of his seed-beds, is able to plant up his fields with healthy, vigorous, well-grown seedlings, will normally have to do little or no replanting. The result will be even growth in the field and even maturing of the leaf. The importance of this latter point cannot be stressed too strongly, as the harvesting of leaf of even maturity is essential if success is to be obtained in curing.

PERCHING.

G. D. SHAW, Poultry Adviser, Department of Agriculture.

It has been the practice to condemn any system of perching which does not conform to the principle of "all birds on the same level." The complaint against perches being on the ladder system has been concentrated on the one factor of fighting for the highest perches.

This accepted rule has made the industry adhere to level perching, no matter what other factor in housing may improve on design. The writer himself had little reason to doubt this condemnation and was naturally surprised to see the ladder principle successfully applied on the property of Mr. R. Hamley, Wembley, Western Australia.

During an inspection of this property, a style of ladder perching was seen, and when questioning Mr. Hamley about fighting and ove crowding his replies suggested that the wholesale condemnation might have been without foundation, so much so that experiments were conducted on another property for four months.

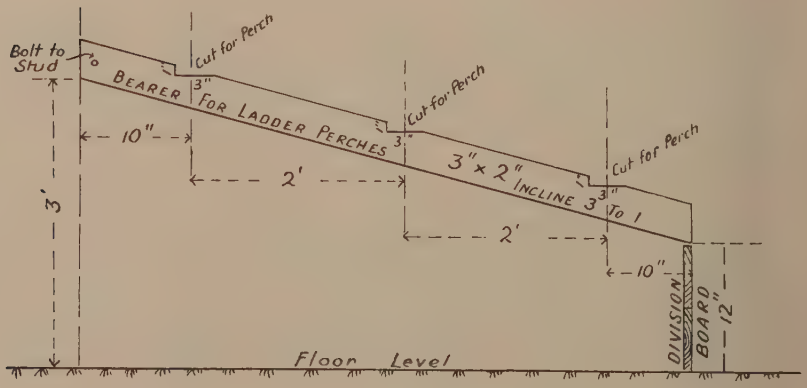
In the four sections of a poultry shed—each section containing 150 fowls on level perches—there were installed, one set of ladder perches side by side with one set of level perches, each set being of three perches 12 feet long. The ladder perches were placed on an incline of 2 feet higher at the back than at the front (an incline of 1—3), each perch 2 feet apart.

The perches were spaced as follows:—

Top perch—10in. from back wall, 3ft. high.

Second perch—2ft. from top perch.

Third perch—2ft. from No. 2 perch, 15in. high.



It was noticed that there was a tendency to crowd the top perch, but this quickly ceased as each bird was apparently settled to a particular perch, and after seven days no crowding took place, each perch being comfortably filled, with no fighting for top positions.

It will be noticed that perches on an incline definitely keep the heads of the birds apart. This advantage allows of a very free circulation of air.

Another feature most marked was the elimination of floor crowding. Some birds will always crowd in the corners of the house under the perches. Previous to installing the ladder perches, there were 14 birds in one section which were under the perches in the corner, and colds were prevalent in the flock.

On the first night of the experiment, it was noticed that these floor birds had left the corner and were on the floor under the birds perching under the level section. Observations over two months were so convincingly in favour of the ladder system that in all sections of the shed complete sets of ladders were gradually installed.

The first night of complete installation of ladder perches in the first section was watched with interest. Birds which had been continuously perching on the level perches with the floor birds beneath, showed no hesitation in occupying the ladder perches, and what was most remarkable was that the floor birds also perched. No reasons can be given for this immediate refusal to stay on the floor of the house.

Another section of the shed was then converted and the sequence of events were consistent with those of the first section—even the floor birds disappeared.

The perches on level bearers were spaced 2ft. 4in. apart, this being the average spacing required for free circulation of air. With the ladder perches, 2 feet is quite sufficient, all the more so when it is seen that 90 per cent. of the birds settle down facing the front of the shed.

The heads of the birds are then 2 feet apart (a decided factor in the prevention of colds, etc.).

The experiment has proved that the ladder perching at an incline of 1—3 is successful and the following points are of interest:—

(1) Less perching space is required due to the incline of the perches.
(2) There is less danger of overcrowding.
(3) There is less tendency for birds to rest on the floor in preference to perching.

"ROPE" IN BREAD.

By L. W. SAMUEL,
Cereal Research Officer.

DEFINITION AND SYMPTOMS.

"Rope" is the name given to a bread disease which results in the breaking down of the starch and protein of the loaf, producing a discoloured and sticky condition in the crumb, accompanied by a characteristic disagreeable odour and nauseating taste.

"Ropiness" in bread is not noticeable directly after baking, but usually makes its appearance from 12 to 36 hours after the bread has left the oven. This bread disease is most liable to occur during the hot humid months and very rarely occurs during cold winter months.

The first indication of "rope" is a very slightly fruity smell in the loaf, but the odour rapidly becomes marked and unpleasant. When the bread is cut, at say about twenty-four hours old, the loaf is observed to have a faint sickly smell, and brown spots are visible in the crumb. As the bread ages these develop further and the substance of the bread changes locally to a thick gummy mass. On touching this a long stringy fibre may be drawn out—hence the name "rope." At the

same time there is developed an intense, disagreeable odour which has been likened to a mixture of rotting fruit and bad cheese.

"Ropy" bread, although unpleasant, is not dangerous if eaten, but because of its unpalatibility an outbreak of rope in the bakehouse is very serious as it may completely ruin the trade.

CAUSE.

"Rope" is due to the growth and multiplication within the loaf of a bacterium known as *Bacillus mesentericus*. Several members of the *mesentericus* group of bacteria cause "rope" and many of these have been isolated, but the variety which is usually responsible is *B. mesentericus vulgatus*, a tiny rod-shaped organism visible under the microscope. This group of organisms is classified as spore formers; that is, if conditions are unfavourable for growth, the bacterium is capable of assuming a resting, resistant form, known as a spore. The "rope" spores are resistant to heat and when present in bread doughs they are not killed by the heat of the oven for the temperature at the centre of a loaf of bread rarely exceeds the boiling point of water (212 deg. F.). If subsequent conditions are favourable the spores develop and multiply, causing the condition known as "rope."

The "rope" bacterium occurs naturally in the soil and is most frequently present on the outer parts of vegetables and grains. Even when thorough wheat cleaning, washing and brushing are carried out there still remain some of the bacteria in the flour. That it is widely distributed is proved by the fact that it is found to a greater or lesser extent in practically all flour in every part of the world. The number of spores increases with decreasing grade of the flour, that is, with increasing proportion of branny particles and more particularly in wheat meal.

The "rope" spore content of a goood flour is about 10 to 20 per gram. If the count is as high as 80, for example, this does not mean that "rope" will occur, but it does mean that this flour is more likely to give trouble than a normal flour.

Flour, however, is not the only raw material used in the bakery which is likely to contain rope spores, as anything originating in the soil may become contaminated. This includes hops, grain and bran used in yeast making, potatoes used in the ferment or even the water itself. Also it must be remembered that like other bacteria and mould spores the "rope" organisms are present to a certain extent practically everywhere in the air and are carried by dust particles.

B. mesentericus is exceedingly resistant to heat, even six hours' boiling in water may not destroy all the spores, so that the boiling of the grain, potatoes, etc., is no protection against it. With modern compressed yeast, however, it may be laid down as a general rule that it is very unlikely that the yeast is responsible for the infection because compressed yeast is grown commercially on a slightly acid medium and the "rope" organism will not develop under mildly acid conditions.

Since "rope" spores are present to some extent in practically all bread, it is not their presence which causes "ropiness" but their growth and multiplication, and for this three factors are necessary—warmth, moisture and a slightly alkaline medium. Thus "rope" is most liable to develop in warm, humid weather. It has been shown that "rope" will not develop in bread kept below 65 deg. F., but develops rapidly at temperatures higher than 77 deg. F. and it appears that 100 deg. F. is the most favourable temperature.

PREVENTION.

Since "rope" in bread is due to the growth and multiplication of *Bacillus mesentericus*, the spores of which are always present, the method of preventing "ropiness" is to render the conditions unsuitable for this growth and multiplication and this is possible in several ways, none of which is as drastic as the old method of burning the bakehouse.

To reduce moisture and warmth the bread should be cooled as rapidly and as effectively as possible. The bread should not be stacked closely in an enclosed space as this retains both warmth and moisture which favour the growth of the spores. Space should be left between individual loaves for the free circulation of air.

The "rope" organism will not develop in mildly acid conditions and it is possible to arrange the acidity of the dough so that "rope" is prevented without any detectable effect on the flavour or quality of the loaf. Indeed, it has been stated that mild acidity produces a better loaf. A large number of substances may be added to the dough mix to insure the proper degree of acidity, the most common ones being vinegar and acid calcium phosphate. A pure grade of acid phosphate should be used at the rate of some 17 ozs. per sack of 150 lbs. Vinegar, preferably white vinegar, should be used at the rate of 2 to 2 2-3rds pints per sack of 150 lbs. on the assumption that the vinegar contains approximately 4 per cent. of acetic acid. A home bake of 7 lbs. of flour would require 2-3 ozs. of vinegar.

The acidity of vinegar is due to its acetic acid content so glacial acetic acid may be used in the bakery instead of vinegar if desired, the rate being $1\frac{1}{2}$ to 2 ozs. per sack of 150 lbs. Other acids, such as lactic acid and tartaric acid, could be used.

Any of these materials is added to the dough batch by merely first stirring it into the bulk of the water, thus forming a dilute solution of the acid substance. When vinegar is used it must be remembered to reduce correspondingly the amount of water used in doughing up. Thirdly, as previously mentioned, the bread should be cooled as rapidly and as effectively as possible as the organism does not develop below 65 deg. F.

In the bakehouse proper there are modifications which tend to reduce the incidence of "rope." Because acidity is inimical to the development of *B. mesentericus* a "green" dough is more subject to it than is a fully matured dough, a dough straight off the yeast is more susceptible than one off a ferment and a sponge dough least of all. Also warm dough temperatures are more conducive to the development of the "rope" organism than cooler dough temperatures; the yeast should not be stinted and a vigorous fermentation lessens the likelihood of the bacteria thriving.

As moisture encourages the growth of "rope," an under-baked loaf is more susceptible than a well-baked loaf. Thus, it is important to avoid flash heat in the oven which results in the crust forming too quickly and necessitates the removal of the bread from the oven before the interior is properly baked, and the excessive moisture in the crumb may result in the appearance of "rope" where it might not otherwise occur. Similarly, the dough could be set a little stiffer by using slightly less water and the bread could be baked out just as far as possible without impairing its qualities.

General cleanliness in the bakehouse is, of course, the first essential from all points of view, and this includes "rope." Care should be taken daily to remove dust, dough, grease, flour, crumbs, etc. from the walls, floor and equipment, as the dust arising from such particles of waste material is apt to carry and distribute "rope" infection throughout the bakery. Stale bread or other stale baked goods should not be allowed to accumulate in the bakery and form breeding places for "rope."

In the event of an outbreak of "rope" in the bakehouse, it must be remembered that, in addition to the above preventive measures, the bakery must be disinfected. It should be cleaned out well, getting rid of all old doughs and particularly returned

bread which should be burnt. The troughs, tables, etc., should be scrubbed down with vinegar. The floor and walls should be scrubbed with formalin (one part of commercial 40 per cent. formalin to twenty parts of hot water). Though the fumes of formalin will not harm the equipment the liquid should not come in contact with the troughs or machines. After washing the floors with formalin they should be washed thoroughly with hot water for formalin is a powerful disinfectant and will kill yeast. For this reason the formalin fumes should not come in contact with flour or other ingredients which might absorb the fumes and thus prevent yeast activity in subsequent doughs.

REFERENCES.

The Practice and Science of Breadmaking (1934), by D. W. Kent-Jones.

A Treatise on Baking (1935), by Julius E. Wihlfahrt.

Bread Baking in New Zealand (1934), compiled by Bycroft, Ltd.

A Study of Rope in Bread. Cereal Chemistry, 1928, 5-192-208, by E. A. Fisher and P. Halton.

AVOID ILL-TREATING THE LAMB.

N. DAVENPORT,
Senior Agricultural Adviser.

It is found necessary to call farmers' attention to the need for the careful handling and treatment of lambs on the farm and during transit to the markets or abattoirs. Far too many lambs, on being dressed, show unsightly bruises and injuries.

The effect of such blemishes is to reduce the value of the carcases considerably, particularly those intended for export. Slightly bruised carcases suffer in grading and a lower price per lb. must be accepted, while those more seriously bruised are rejected and must be sold locally.. In the latter case a reduction in value up to 6s. or even more, per carcase, may result. It is therefore to the advantage of the lamb producer to eliminate the causes of this bruising as far as possible. The most common are, catching or picking up the lambs by the wool; hitting or prodding them with a stick or other hard object; when drafting or loading, allowing them to become overcrowded in a confined space as when passing through a race in the yards or into a truck; the use of a dog without a muzzle (a slight nip will leave a tell-tale bruise).

It is obvious that, by taking reasonable care, bruising can be largely eliminated.

The following rules should be observed:

Don't pick up lambs by the wool.

Don't prod or strike with a stick or other hard object.

Don't overcrowd.

Don't let the dog bite.

DISEASES OF FARM ANIMALS AND THEIR TREATMENT.

A. McK. CLARK, L.V.Sc.,
Chief Veterinary Surgeon.

From time to time many inquiries are received from stock owners asking for veterinary advice and treatment for sick stock, and with the object of supplying this information in a handy and easily understood manner, these notes bearing on common ailments of stock have been compiled. It is hoped that they will prove of value to those requiring such assistance.

In detailing treatment those drugs which are easily procured by the stock-owners in country districts are recommended whenever possible. However, when the registered veterinary surgeon is accessible, his services should be availed of.

COMMON MEASURES FOR DRUGS.

One teaspoonful = one fluid drachm.
One dessertspoonful = two fluid drachms.
One tablespoonful = one-half fluid ounce.
One wineglassful = two fluid ounces.
One common cupful = one-half pint or 10 ounces.

HOW TO DRENCH.

Horses. The drenching bit should be used. Failing this, a headstall should be placed on the animal and a rope tied to the nose strap. The horse should then be backed into a stall and the rope thrown over a rafter or beam in the stall. The head is then pulled sufficiently high to allow the fluid to gravitate into the gullet. The drench should then be poured from a bottle into the corner of the mouth and the animal made to drink it at will. The following precautions should be observed:—

(1) Do not raise the head too high.
(2) Should the animal cough lower the head at once.
(3) If the horse refuses to swallow pass the hand into the mouth and withdraw the tongue.
(4) Do not rub or strike the outside of the throat.
(5) Above all have patience.

Cattle.—These animals may be drenched in a stall. The operator then stands on the left side and passes his right hand over the poll through the horns, and grips the right side of the upper jaw. On pulling upwards the nose is elevated and the mouth opened. The drench is then placed into the mouth on the left side from a bottle held in the left hand. Care should be taken that the drench is given slowly and quietly, as, owing to the short and wide windpipe, it is likely to be gulped into the lungs. For this reason oily drenches should be avoided, as these drugs, if forced into the windpipe, cause death from suffocation.

Sheep.—No difficulty is found in drenching sheep. The liquid is poured into the mouth by elevating the head with the hand under the lower jaw. The sheep should be drenched in a standing position like the larger animals.

Pigs.—The administration of drugs to pigs should not be attempted by force, as this method, apart from being cumbersome and awkward, may result in choking. It is always best to give these in the food supply. The pig being a rapacious feeder, no difficulty is usually experienced in enticing it to take drugs in the food.

WORMS.

Animals are effected with two kinds of worms, *i.e.*—

Tape Worms, and
Round Worms.

The tape worms are not responsible for such heavy losses as the other kind, which include several dangerous varieties.

Animals may be infected by grazing on moist badly drained land in winter time, when they will pick up the worm eggs attached to the grass, and after hatching out these parasites become mature and reproduce their species, the eggs being passed out with the excreta to reinfest the pastures. The most harmful worms found affecting horses are round worms, especially Strongyles, which are about an inch and a half in length. These cause losses in young or debilitated horses when the animals are allowed to graze on infected pastures. The horse's stomach is sometimes infected with tumours due to the presence of habronema. In these cases digestion is interfered with, and horses so infected become emaciated.

Horse bots in the stomach are not usually responsible for any sickness or death, this being due to other causes.

Sheep and cattle are chiefly infected with Stongyles in the stomach. These cause parasitic gastritis and emaciation. Bottle-jaw in sheep is due to the presence of these parasites.

Pigs which fail to thrive are sometimes found to be infected with Ascarides or the Œsophagostomum dentatum in the intestines or the Stephanurus dentatum in the fat around the kidneys.

Dogs are chiefly infected by tapeworms, and should be kept off pastures when not working, and treated with worm medicines. They should be treated for worms every three months.

Lung Worms.—These attack all the domestic animals, especially sheep. They may be found by slitting the windpipe down to the smaller bronchi, where they appear like tangled masses of white thread.

Symptoms.—Horses with worms fall away in condition, the appetite becomes morbid, and the coat becomes rough, and occasionally attacks of colic will occur. Worms are often passed in the faeces, and the animal becomes "pot-bellied" due to the accumulation of dropsical fluid.

Cattle when affected with parasitic gastritis fall away in condition and become emaciated and suffer from diarrhoea, although on good feed. They also develop dropsical swellings on the lower portions of the body, *i.e.*, brisket, belly.

Sheep when affected with parasitic gastritis fall away in condition and develop "bottle-jaw," which is an accumulation of dropsical liquid in the intermaxillary space. They also become "pot-bellied." Very often there is a high mortality from this disease.

Sheep with Lung Worms show signs of persistent coughing, with the head held in an extended position. Coughing is most marked on cold mornings.

Treatment and Precautionary Measures.—Overstocking should be avoided, the land should be drained, and windmills and troughs erected. Never allow young animals to follow old ones in the paddocks. Put young animals on to fresh paddocks.

Horses.—Give rock salt in mangers. Starve for 24 hours, and afterwards give the following:—

Linseed Oil, 1½ pints, with Oil of Turpentine, 3 ounces, or with Oil of Chenopodium, ½ ounce; or Thymol, 15 grains night and morning.

Supply the following powder in the feed:—

Antimony Tartrate, 1 ounce.
Sulphate of Iron, 1 ounce.
Powdered Gentian, 4 ounces.

Divide into eight powders and give one in the feed every morning for eight days. Repeat linseed oil, 1½ pints, after seven days.

Pigs.—Give in the feed Calomel up to 1 drachm, powdered Jalap 1 to 3 drachms, or 1 to 4 teaspoonsful of Oil of Turpentine in milk according to the size of the pig. Another useful mixture is Oil of Chenopodium 2 ounces with Castor Oil 16 ounces. Give each pig up to two tablespoonsful of this mixture, according to the size of the animal.

Lice on Pigs.—The body should be smeared with vegetable oil or animal oil, or a mixture composed of 1 pound of soft soap, 1 pint of kerosene, and 1 gallon of water.

Dogs.—These are subject to infestation with several varieties of tape worms. The intermediate stage of these worms is found in cattle and sheep, consequently all dogs on stations should be kept away from slaughter-houses and free from worms by dosing at intervals with freshly ground Arecanut, 2 grains for every lb. of body weight. Thus if a dog weighs 60 lbs., he would require ¼ ounce of Arecanut, and this should be given in glycerine or castor oil, 1 ounce. Keep dogs tied up when not at work, and destroy all fæces.

Valuable sheep or cattle with Lung Worms may be treated by injecting medicines into the windpipe with a hypodermic syringe. Further particulars of this method may be obtained on application to this Department.

HORSES.

COLIC.

Colic is the manifestation of pain in the interior of the abdomen. It may be due to irritation of the intestines caused by indigestion, sand, worms, enteritis, hernia, calculus, or obstruction.

Flatulent Colic.—This is abdominal pain due to distension of the bowels by gas resulting from undigested food or foods which generate gases, *i.e.*, Clovers. Usually it is due to errors in feeding, watering, and working.

Symptoms.—In this case the symptoms resemble those of Spasmodic Colic, but are less violent, and there is considerable distension of the abdomen, shown by the hollow of the flank becoming filled up and completely obliterated. Owing to pressure exerted by the distended bowels on the lungs and heart, breathing is difficult, and as the lungs cannot obtain enough oxygen the blood becomes de-oxygenated and brain symptoms thus occur.

Treatment.—Starve until recovering.

Give Sp. Ammon. Arom., 1 ounce.
Ether nit., 1 ounce.
Warm water, 1 pint,
or
Whisky or Rum, 6 ounces
Water, 1 pint.

Follow up with—

Linseed Oil (Raw), 1½ pints.
Oil of Turpentine, 1 to 2 ounces.

Spasmodic Colic.—This is abdominal pain accompanied by spasms of the muscular coat of the intestines. It may be due to the irritation caused by undigested food as the result of the teeth being out of order, or it may be due to the horse working too hard or for too long a period.

Symptoms.—The first symptoms are usually depression, pawing with a fore foot, looking round at the flank and making attempts to lie down carefully; later rolling, rapid breathing, distress and sweating. At intervals the pain disappears only to return and becomes gradually worse until, if not relieved by medicine, the horse will gradually show a haggard expression of the face, cold and wet surface of the body, and finally die in agony.

Treatment.—Starve until recovering.
Give Aloetic Ball, 5 to 8 drachms.
Chloral Hydrate, 1 ounce.

Also given enemas, exercise, laxative diet. Repeat purgative, if necessary, by giving Linseed Oil, 1½ pints; Oil of Turpentine, 2 ounces.

Sand Colic.—This is abdominal pain due to the irritation caused by sand in the bowels. Horses when not supplied with Rock Salt, or when put on to sandy paddocks to graze when the green feed is just coming up, will eat large quantities of sand. Sometimes the eating of sand is the result of defective bag mangers, out of which the chaff becomes split and is then eaten off the ground together with sand.

Symptoms and Treatment.—Suspected horses should be kept in a clean yard so that their dung may be examined for sand. Back raking with a well greased arm will often reveal the presence of sand inside the rectum. After administering a dose of linseed oil (raw), 2 pints, and turpentine, 2 ounces, sand will usually be passed in quantity after 24 hours. The same symptoms are present as in other forms of colic with a greater tendency to signs of inflammation of the bowels, *i.e.*, Enteritis. The foregoing treatment may be repeated in pint doses after 24 hours interval, and soapy enemas may also be given and repeated if necessary. Horses affected with bowel trouble should be starved or given bran mashes only and plenty of water.

In mild cases 1 lb. of pure honey should be given in a bran mash.

ENTERITIS OR INFLAMMATION OF THE INTESTINES.

This is a rapidly fatal inflammation of the mucous membrane of the intestines, due to neglected cases of colic or to other causes, such as worms, poison plants, constipation, bacteria.

Symptoms.—Redness of mucous membrane of eyelids and nostrils, high temperature, restlessness, uneasiness, pawing continuously, breathing hard, sweating, pain on pressure with hand on abdomen. There is no relief from pain until just before death occurs. Countenance shows great distress, eye is wild—unnatural stare—nostrils dilated. Shivering occurs and the skin gradually becomes cold all over; lips become pendulous. Pain ceases just before death owing to gangrene of the bowel having set in and then pain can no longer be felt.

Treatment.—Give anodynes to allay pain—Chloral Hydrate, 1 ounce in a pint of water—this may be repeated as required. Apply hot fomentations to abdomen with a blanket. Give warm water enemas frequently; regulate bowels if necessary with Olive Oil, 1 pint. Avoid dry foods until recovery takes place. Give small bran and linseed mashes and do not work the animal until a week after recovery.

IMPACTION OF COLON.

This is the accumulation of coarse fibrous or over-abundant food in the colon and caecum accompanied by general abdominal pain.

Symptoms.—There is an absence of defecation and loss of appetite, which gradually become more pronounced. This trouble is less violent than ordinary colic and appears gradually, the animal sometimes only showing symptoms of loss of appetite and slight pain shown by rising and getting down alternately. When standing, the horse will attempt to micturate or make water without doing so. This act will be repeated several times, leading to the erroneous idea that the horse is suffering from kidney trouble. The urine is darker than normal but becomes normal after recovery of the action of the bowels. On listening to the bowel movement by placing the head against the flank there is an absence of the usual sounds. Horses with this trouble do not usually recover unless treatment is persevered with for a week or two. The first two or three enemas may not be followed by the passage of dung, and must be repeated eight or nine times a day until the food passes through.

Treatment.—Give laxative diet and soapy enemas. Three packets of Glauber's Salts in the feed daily may be given, but in the more severe cases give—

Ammonium carbonate pulv., 2 ounces.
Nux Vomica, 1 ounce.

Make into four balls and give as one done. This should be followed with—

Raw Linseed Oil, 1½ pints.
Oil of Turpentine, 2 ounces.
Sp. Ammonia Arom., 2 ounces.

Repeat without Nux Vomica, if necessary.

LAMINITIS OR FOUNDER.

This condition is an inflammation of the sensitive or fleshy leaves of the wall of the foot, due to congestion of the circulation. This may be due to one of several causes, *i.e.*, long standing on hard ground in hot weather or the result of an over-liberal allowance of grain in the ration or undue weight being supported by one hind or forefoot whilst the other fore or hind foot is injured and unable to support weight. The disease is also met with after parturition or when animals are approaching parturition and sometimes follows influenza. It may also be due to excessive work, intestinal congestion, improper shoeing.

Symptoms.—The first signs of this disease are loss of appetite, increased thirst, and unsteady gait. Later the symptoms vary according to whether the fore or hind feet are affected. If laminitis of the fore feet the horse will throw all the weight on the heel and thus has to stretch the fore feet forward; in addition he will relieve the fore feet of as much weight as possible by bringing the hind feet forward under the belly. If the hind feet are affected the horse will endeavour to throw his weight on to the fore feet by drawing these back under the body and lowering the head and neck; at the same time the hind feet are brought forward in an endeavour to place the weight on the heels. The affected hoof will be found to be hot, especially around the wall, and it will be difficult to lift any of the feet off the ground. The artery which runs down the pastern throbs and the legs usually "fill." The horse will refuse to lie down or move. When forcibly moved he appears to have the feet nailed to the ground. The breathing is hurried, membrane of the eye red—due to congestion. If treated early no further developments occur and recovery occurs in a few days; if neglected, chronic laminitis with permanent changes in the structure of the foot will occur. Usually if recovery has not occurred by the eighth day chronic laminitis will be present, and the pedal bone will descend and the wall of the foot becomes concave, with an excessive growth

of hoof at the toe. Haemorrhage between the wall and the bone may produce "Seedy Toe," which is a hollow space between the wall and the bone, and will have to be cut out. The pedal bone may penetrate the sole and the protruding portion sluff away. Chronic cases may become acute at any time, especially if worked on hard roads.

Treatment.—Give purgative as soon as possible—Arecolin Hydrobromide, 1½ grains, subcutaneously, or Linseed Oil, 1 quart. Remove shoes. Put in paddock with soft ground or tie in stream or puddle. Keep bowels well open with Epsom Salts in feed of bran mashes with little chaff. Exercise as soon as pain disappears, but not before. In addition give enemas of cold soapy water. Feed on green stuff and allow plenty of water. Three or four ounces of Sodium Bicarbonate should be given in bran mashes if green feed is not available, and a little in the drinking water. If cold water, ice, sea or stream is available the horse should be allowed to stand in it. Shoeing adjustments should be made to throw the weight on to the frog. After recovery blister the coronet.

CHRONIC LAMINITIS.

This is incurable, but horses so affected may remain in work on soft ground if the weight of the foot is kept on the frog and the wall kept rasped down. The sole must not be allowed to touch the ground, and it is advisable to put a leather cover between the wall and the shoe. After work the horse should be allowed to stand in wet sand, or on straw or soft ground.

STRANGLES.

This is an infectious disease due to bacteria, which usually affects young horses when brought into town and allowed to drink out of public horse troughs. It causes catarrh, and when the lymphatic glands under the jaw are infected they swell and finally form abscesses and swelling of the throat under the throat strap.

Symptoms.—The horse becomes dull, loses his appetite and becomes feverish, temperature rising to 103 deg. F. or higher. Discharge of pus from the nostrils, the mucous membrane being a dark red colour. Sometimes the glands escape infection but usually after a few days they commence to swell and in about 10 days require lancing with a sharp knife. Whilst maturing the swellings should be rubbed with embrocation daily and not opened until almost bursting. After abscesses are opened the animal usually recovers. Complications may occur due to extension of the catarrh towards the lungs and stomach, and the germ may enter the general circulation setting up abscesses in the kidneys, liver, lungs, and joints. When the temperature rises to 104deg.-105deg. F., it is usually a sign of complications being present and usually if death occurs it is due to septicaemia. Purpura haemorrhagica sometimes follows attacks of strangles, in which case the head and legs will gradually become oedematous and swollen and the skin exude serum in patches. The swelling becomes well marked, in some cases interfering with breathing, and most of these cases end fatally after a long illness.

Treatment.—Isolate affected animals. Steam head with gum leaves and hot water. Make liniment from—

Turpentine Oil, 1 ounce.
Strong Liquid Ammonia, 1 ounce.
Olive Oil, 4 ounces.
Plain water or distilled water, 8 ounces.

Rub swellings around throat daily or apply blister of Biniodide of Mercury—1 in 4. When abscesses mature, open and obtain good drainage. Feed green stuff or bran mashes and keep stable clean. Valuable animals should be treated with

antistreptococcal serum. If the breathing is difficult a tracheotomy tube should be inserted in the windpipe. Avoid drenches—give medicine in form of electuary (mixed with treacle) and smeared on the tongue.

Extract of Belladonna, 1 ounce.
Potassium Chlorate, 4 ounces.
Ginger, 4 ounces.
Treacle, sufficient quantity.

LOCKJAW OR TETANUS.

This is a nervous disease manifested by continuous contraction of the voluntary muscles, due to the absorption of toxins from the tetanus bacillus, which usually enters the body by means of a wound coming into contact with infected ground. It may also follow operations. The germs of tetanus are found all over the world especially in old pastures. The period which elapses between the introduction of the germ and the appearance of first symptoms is very variable and extends from two to 14 days, and is usually not less than a week.

Symptoms.—These usually last from three days to six weeks, and if horses live after nine days they sometimes recover. The first muscles affected are usually those of the face, which give the horse a drawn expression. The other muscles soon follow, and the mouth becomes fixedly closed, the nose poked out, the neck curved. The tail becomes raised and quivers. The limbs appear to be propping him up, and great stiffness is shown on movement. The diagnostic symptom is the haw of the eye, which will protrude when the horse is struck lightly under the jaw. Any excitement will aggravate the muscular twitching. After three weeks horses show signs of recovery, if they are going to recover. Convalescence is very long.

Treatment.—Keep animal in a quite, dark loose-box; leave undisturbed. Give liquid food. Calomel should be given on the tongue, as much as will cover a sixpence, to regulate bowels. Add tincture aconite, 1 teaspoonful, to drinking water daily. Anti-tetanic serum should be used before operations on valuable animals.

The original wound should be searched for, *i.e.*, a pricked foot, and if found should be cauterised thoroughly with a hot iron or caustic, *i.e.*, 40 grains of Chorlide of Zinc to an ounce of water, or Tinct. Iodine. Liquid food should be given, such as milk, beaten-up eggs and gruel, which the animal will be able to suck up although unable to chew. Chloral hydrate, 2 ounces daily, may be added to the gruel to allay the nervous symptoms.

TOXIC PARALYSIS OR FORAGE POISONING.

This disease usually affects chaff-fed horses and rarely those pasture-fed. It runs a course of from 48 to 72 hours, and in some cases death may result in 12 hours. The death rate may be up to 100 per cent. of the animals showing symptoms.

Symptoms.—The first signs noticed are usually unsteady gait and sluggishness. These increase in intensity more or less rapidly and are accompanied by an increasing weakness and loss of power. Eventually the animal lies down and rises with difficulty. As the disease progresses the animal becomes totally unable to rise, death usually occurring in from 24 to 48 hours after the animal goes down. In other cases symptoms may be difficulty in swallowing; this progresses slowly—the animal refusing food and drinking with difficulty.

Cause.—The cause of this disease is a specific germ infection of the food supply, possibly following contamination by infected animal tissues such as dead mice, rats, etc. The food supply may not necessarily show evidence of this by examination and may appear perfectly wholesome.

Treatment.—No sure remedy is known and treatment is, therefore, of little avail. Horses affected should be placed in slings as soon as the first signs of the disease are noticed. Feed on damped bran and chaff with a little green stuff. Add to the food supply one drachm of powdered Nux Vomica twice daily.

Preventive precautions should be adopted by endeavouring to locate the source of the infection. This is often difficult. The only way to eliminate such infection is to immediately secure a supply of chaff from outside sources. All bins and mangers should be cleaned out thoroughly and disinfected with a 3 per cent. solution of Izal and food supplies destroyed.

WHEAT POISONING.

This results from horses engorging wheat. The symptoms of colic are noticed and subsequent founder of the feet. The condition is caused through a poison in the wheat and not through the mechanical action of the wheat swelling as is generally supposed amongst stock-owners.

Treatment.—Allow horses as much water as they can drink. Give as a purgative 1 pint of Raw Linseed Oil and Bicarbonate of Soda 3 ounces.

MANGE.

This is a contagious skin disease caused by the presence of a minute parasite which burrows into the skin and lives under the crusts which are formed by the drying up of the fluid from the pimply eruptions which it causes. This disease is conveyed from animal to animal by means of harness, brushes, etc., and by direct contact.

Symptoms.—The puncture made by these mites give rise to an eruption of small pimples which are first in the nature of blisters. They cause irritation and inflammation and the skin eventually becomes thickened, hardened, wrinkled, devoid of hair, and more or less covered with scales.

Treatment.—Wash the surface of the skin by scrubbing with warm water and soft soap. After allowing to dry, rub over daily with a mixture composed of Potassium Sulphurata, 1 ounce in 2 gallons of water.

RINGWORM.

A disease characterised by loss of hair in round patches throughout the coat. It is due to a fungus. This fungus or vegetable parasite penetrates the hair follicles and sets up inflammation and attacks the hair roots, making the hair dry and brittle so that it readily breaks. This disease is contagious and is spread by means of stable implements, saddlery and harness.

Symptoms.—It appears in circular patches devoid of hair with a clearly defined edge, the diameter of which is one-half to two inches.

Treatment.—Recovery is often spontaneous, but this is assisted by painting the affected part daily with strong tincture of iodine.

GREASY HEELS.

This is a form of eczema affecting the pastern and fetlock joints.

Symptoms.—These are characterised by the animal firstly stamping its feet. Later a sticky substance is noted issuing from between the hairs about the joints with a particularly evil smell. If not attended to, the hairs will fall out and a raw granulating surface make its appearance. This latter stage should be prevented if possible, as it gets more or less chonic and almost impossible to effect a cure.

Treatment.—The affected parts should be washed with soft soap and warm water, and after drying, applications of the following should be applied daily: A solution composed of Salicylic Acid, ½ ounce in 1 pint of methylated spirits, or Zinc Sulphate 1 ounce, Lead Acetate 1 ounce, mixed together in a pint of water. Water should not be applied after the first washing.

GALLS.

The common site for these injuries is the shoulder. There is no specific treatment for galls, and such injuries should be treated as common wounds. They are due mostly to ill-fitting and dirty collars. They should therefore be prevented by providing a collar which fits well. Leather-lined collars are an advantage as they can be washed and oiled. In the early stages, before the sores have become raw, relief is often obtained by applying night and morning Zinc Oxide ointment. When they are raw, White Lotion should be applied. This should be made by mixing the following.

Zinc Sulphate—1 ounce.
Lead Acetate—1 ounce.
Water—1 pint.

When the horses return from work the shoulders should be washed down with cold water.

OPHTHALMIA OR INFLAMMATION OF THE EYE.

This condition is usually caused by an injury such as a whip crack or chaff in the eye. If due to the latter the eye should be closely examined and the chaff removed. This may be done by rolling a piece of paper and, with its pointed end, lifting the chaff from the surface of the eyeball. The injuries thus caused by the chaff or the whip should be treated by placing the animal in a dark loose-box or placing a cover over the eye to protect it from the sun's rays and dust. A solution made up as follows should be syringed into the eye twice daily:—

Extract or Belladonna—10 grains.
Zinc Sulphate—90 grains.
Distilled Water—1 pint.

WOUNDS.

Wounds are divided into three classes:—

1. Incised, or clean cut.
2. Punctured.
3. Bruised.

The second class of wounds are the most dangerous, as they are more likely to be followed by lock-jaw, and there is greater difficulty in securing drainage, and further, they are more liable to implicate bones and other deep structures. In all cases, the following steps are necessary to insure healing:—

(a) Stop the bleeding by applying pressure.
(b) Remove all dirt, clots of blood, and any foreign body, *i.e.*, stakes.
(c) Destroy germs with antiseptic dressings.
(d) Bring the edges of the wound together, if possible, with sutures.
(e) Rest the part.
(f) Dress the wound.
(g) Secure drainage to the exterior of all discharges.

ABSCESSES.

An abscess is a collection of pus enclosed in any part of the body. It is usually due to the introduction of pus-producing germs which are caught in various parts of the circulation when it is too small for them to pass through, *i.e.*, joints capillaries, lymph glands, etc.

Symptoms in the case of abscesses are tenderness, heat, swelling, throbbing and pointing; when pressure is applied to a mature abscess with the finger tips the contents will fluctuate.

Treatment.—Before mature foment with hot water, and use embrocation daily until mature. Open when mature and secure good drainage.

SPRAINED TENDONS.

A sprain is an injury inflicted by excessive force, with the result that the fibres are overstretched, broken, or torn away from the bones.

Treatment.—Use cooling lotions and rest if inflamed. Acetate of Lead, 1 ounce; Sulphate of Zinc, 1 ounce; cold water, 1 quart. Apply a flannel bandage or puttee soaked in this lotion. Renew twice daily. Blister after the inflammation has disappeared with Biniodide of Mercury and lard, and turn animal out for rest.

CATTLE.

DISTENSION OF RUMEN.

This is a form of indigestion caused by the animal gorging itself with food, and arises more from the animal's voracious appetite than from any defect in the quality of the food supplied to it. The condition is, however, more severe if the food consumed is especially concentrated or difficult to digest.

Symptoms.—There is no great formation of gas. The affected animal goes off its food, and the milk supply drops. On pressing the flank on the left side with the closed fist the indent of the hand remains for a short time in the flanks as if the rumen were filled with a soft doughy mass.

Treatment.—Give a drench composed of the following:—

Epsom Salts, 1 lb.
Powdered Ginger, 2 ounces.
Treacle, ½ lb.
Water (warm), 1½ pints.

Mix, and give as a drench. Afterwards give three times daily:—

Aromatic Spirits of Ammonia, ½ ounce.
Spirits of Nitrous Ether, ½ ounce.
Water, ½ pint.

MILK FEVER IN CATTLE.

This is a condition which occurs at the termination of parturition and which is manifested by sudden loss of consciousness and general paralysis. It is met with most frequently on farms with succulent food and first-class milking cows. It is more common in heavy milkers, after third, fourth, or fifth calving—especially common after easy calving. It usuall occurs two or three days after calving, but may occur two days before calving. Due to lowering of blood sugar content.

Symptoms.—Two days after calving the appetite declines without visible cause and the animal becomes restless, looking about nervously, bellows, and continually moves hind feet. Weakness becomes noticeable, the animal staggers and sways,

and finally, being unable to stand any longer, falls down. After feeble attempts to rise semi-coma gradually sets in, and the animal lies propped with feet under the belly and the head turned round and resting on the shoulder; if straightened it immediately returns to its original position. The animal may assume other positions, and is sometimes found stretched out on her side, as if dead. Evacuations cease, consequently faeces and urine accumulate. Temperature is usually below normal, and ears, horns, and feet are cold.

Treatment– Inflate udder with filtered air. After treatment cow usually recovers in a few hours; if not, treatment should be repeated. It is dangerous to drench cows with milk fever as they cannot swallow, and the drench will go down the windpipe to the lungs and cause pneumonia.

PROLAPSES OF WOMB.

This is the expulsion through the vagina of the uterus or womb. It may be due to the slope of the ground causing extra pressure on the external orifice or to weakness of the part. Diagnosis can be made by the fleshy structure differing from the cleansing of the womb, which is sometimes found in this position. Often the placenta or cleansing is found to be still adherent.

Treatment- Remove cleansings. Wash gently with weak solution of permanganate of potash. Sprinkle with granulated sugar and allow time to shrink, then replace with flat hands on surface of womb. Before replacement stand the animal with head downhill and give chloral hydrate, 1 ounce in a quart of water.

METRITIS OR INFLAMMATION OF THE WOMB.

A very fatal form of inflammation occurring after parturition in the cow, mare, ewe, bitch, or sow. It is due to blood poisoning by germ infection of wounds in the womb caused by difficult parturition or retained cleansings. The inflammation is characterised by the rapid formation of an abundant quantity of dark chocolate-coloured fluid which is discharged later from genital passage—which causes much straining.

Symptoms.—Restlessness, paddling of hind feet, loss of appetite, suppression of milk. Vulvae small, contracted mucous membrane dark purple with petechial spots. Violent straining with discharge of offensive liquid and foeted diarrhoea, abdominal pain, shown by the animal kicking the belly. These symptoms are sometimes complicated with inflammation of the feet (founder). The breathing is difficult and at last complete unconsciousness sets in, and the animal dies in from 12 hours to two days.

Treatment.—Give aperients, stimulants, i.e., Tincture of Opium, 1 ounce, Aromatic Spirits of Ammonia, 1 ounce, or Whisky, 2 ounces, in a pint of cold water. Irrigate uterus with weak permanganate of potash (Condy's) solution. Apply hot fomentations to loins. Remove placenta if still in womb.

MAMMITIS—INFLAMATION OF THE UDDER.

The exciting causes may be general or local. To the former belong irregularities in diet, and the local causes, bruising or other external injuries. Cows are subject to it when in fat condition at the time of calving or if the animal be turned into a rich paddock when the organ is in high activity. The last cause is a very common one. Inflammation of the udder is frequently caused by the practice of overstocking. This consists in the preparation of cows for show or market by allowing them to go unmilked until the quarter becomes greatly distended.

Acute mammitis seldom attacks the whole udder, but is confined to one or two quarters. Symptoms are expressed by a swelling, heat, pain, and redness of the part, with an alteration in the physical properties of the milk, which is curdled, whey-like, and mixed with blood. There is a general body disturbance, such as shivers succeeded by increased heat of the skin. The bowels are also disordered.

Termination of the Disease.

1. Recovery of the part to its normal condition, which occurs only when the part is slightly inflamed.

2. A very common result consists in the part losing its functions and the formation of hard fibrous mass in place of the normal tissue.

3. Chronic suppuration or pus formation, the gland becoming hard in parts afterwards breaks and discharges pus, or the pus may be discharged through the teat. This is a very common termination in mares, and may result in the animal wasting away in condition, finally dying of septicaemia.

4. Gangrene or death of the part. Through the pressure of the thighs on the swollen udder or through the cow bruising the part during the time it is affected with milk fever paralysis.

Treatment.—If caused from diet, give purgative medicine, and in cattle the following is a useful drench before or after calving:—

Magnesium Sulphate (Epsom Salts), 16 ounces.
Sublimed Sulphur, ½ ounce.
Powdered Ginger, 1 ounce.
Tartrate of Antimony, ½ ounce.
Treacle Water, 1 quart.

If there is fever give, in a pint of warm water, the following:—

Nitrate of Potash, 1 ounce.
Hyposulphate of Soda, 1 ounce.

If the animal is inclined to eat, avoid food with much milk-producing constituents and keep on bran mashes. The local treatment is of great importance. First, milk should be frequently drawn—if it cannot be done by hand a teat syphon should be used. This, with fomentation with warm water, is sufficient for the milder cases, but when the udder is swollen and discharges very thick pus the quarter should be syringed out with weak solution of flavine, 1 in 1,000, or chinosol, using half a pint of solution to each quarter. Allow the solution to remain in the quarter if flavine is used. Repeat three or four times daily. To relieve a very swollen udder a broad bandage should be used, covering the part, and supported round the spine. The udder may be frequently rubbed with the following:—

Belladonna Extract, ½ ounce.
Strong Liquid Ammonia, 2 drachms.
Soft Soap, 2 ounces.
Oil of Turpentine, 1 ounce.
Olive Oil, up to 16 ounces.

This not only relieves the pain but relaxes the teats, which allow of the escape of milk. If suppuration takes place the abscesses are to be opened, pus allowed to escape, and the wounds dressed with weak solutions of potassium permanganate (Condy's). Flavine, 1 in 1,000, is more effective if available.

CHOKING.

In the horse it is generally caused by lodgment of a quantity of food, especially in a dry state such as chaff swallowed rapidly by a greedy feeder, also by a piece of potato or a ball of large size. Eggs forced into the pharynx or gullet often prove a cause of obstruction. Animals with a voracious appetite are apt to bolt

their food and gulp it down so rapidly that the successive portions, instead of passing into the stomach, accumulate in the gullet and block up its canal. Only a small quantity is sufficient to cause uneasiness. All at once the animal leaves off feeding, makes every effort to dislodge the food, and should it not succeed the throat and neck become spasmodically drawn up, and it will give now and then a loud shriek. When attempting to swallow liquids they are returned through the nostrils together with the saliva collected in the mouth. When the obstruction is in the neck a swelling is plainly seen in the course of the gullet on the left side.

General symptoms are:—Great anxiety of countenance; sunken head; tremors; partial sweats over the body and great exhaustion shortly after the occurrence of the obstruction. In the cow the obstruction is generally a piece of turnip, potato, old pieces of leather and bones. Symptoms in the cow are tympanitis (blown), involuntary movement of the jaws, excessive flow of saliva from the mouth; violent cough causing expulsion of faeces or urine.

Treatment.—The tongue should be well drawn out of the mouth and the hand introduced and any pieces of wire in the throat removed. If there is no obstruction in the throat it may be lower down and manipulated on the outside of the neck and pushed upward or downward. Should this method, however, fail it may be removed by causing the animal to swallow liquids, gruels, or an emulsion made by mixing a quantity of oil and water. When these methods fail the probang or whip-handle must be used. This is easier in the cow than in the horse. Care is necessary in the horse to avoid injuring the turbinate bone. If unsuccessful the object may be removed by making an incision through the neck into the gullet just large enough to remove the object; afterwards the wound should be sutured with strong silk stitches with antiseptic precautions.

ZAMIA PALM POISONING ("RICKETS," "WOBBLES").

This is common in dairy cattle which have been running out in the bush in the South-West portion of the State. It is due to the cattle eating the palm and nut, which contain a poison that acts on the nervous system, producing permanent changes in the spinal cord—hence the partial loss of power in the hind legs. Rickets or Rachitis is a different disease, and only attacks young animals.

Treatment.—Preventive treatment is recommended which consist in destroying the palms with kerosene before allowing the cattle on the palm country. Liberal hand feeding is also recommended. The following medicinal treatment is recommended, and should be administered as soon as possible to affected animals:—

Epsom Salts, 1½ lbs.
Common Salt, 6 ounces.
Ginger, 1 ounce.
Treacle, 6 ounces.

Give as a drench with a quart of warm water. Hold the animal's head and neck straight when drenching. This drench is only of use if given soon after the animal has eaten the poison.

TOXIC PARALYSIS.

The pastures in many of our districts are naturally deficient in lime or phosphates.

Animals and particularly milking cows, constantly require supplies of these minerals in order to remain healthly.

Cattle will attempt to make good their mineral requirements, when pastures are deficient, by chewing bones, which are very rich in the necessary elements.

If mineral deficiency is very marked, the animals' appetites become more and more "depraved" and all kinds of rubbish are eaten.

Now there is in some districts a germ (*Bacillus parabotulinus*) which occurs in the soil, and infects carcases of animals, cattle, sheep, rabbits, etc. It is found, and, by reason of its great resisting powers, may remain for considerable periods, in bones of dead animals.

This *Bacillus parabotulinus* produces a powerful toxin or poison. When the bacilli and toxin are ingested (with bones or other parts of carcases which are infected by the germ), particularly by cattle, in a great majority of the cases fatal results ensue. Carcases of animals which have died from the disease are, of course, very dangerous.

The disease produced is known as "Toxic Bulbar Paralysis" or "Parabotulism."

In order that the disease be produced on a property, two factors are essential: (a) Mineral deficiency; (b) presence of *Bacillus parabotulinus*.

Symptoms.—Dairy cows particularly are affected (these animals require large quantities of minerals for milk secretion); young animals not often.

The symptoms produced are due to paralysis of certain portions of the nervous system by the toxin of the bacillus.

In typical cases the animals are unable, or able with difficulty, to masticate and swallow feed. In the early stages there is difficulty in drinking, later no feed or water is taken. There is excessive salivation, and sometimes protrusion of the tongue. The gait is more or less staggering (partial paralysis), and the animal is dull. Rumination is disturbed and finally suspended, and the faeces are scanty. Progressive weakness ensues, the animal lies down and can be got to rise only with difficulty or not at all. Eventually, in from two days to a week after symptoms are first noticed, the animal sinks into a state of coma and dies.

These characteristic symptoms are not always shown. In very acute cases death is sudden; and other cases may be of longer duration than prescribed, the affected animal showing general unthriftiness, loss of condition, and a "cripply" gait.

The bone-chewing habit is constant in all cases.

Diagnosis.—A history of bone chewing, in addition to symptoms more or less as described, would indicate parabotulism. There are no characteristic post-mortem features.

Treatment.—Treatment is of little avail. Do not drench affected animals; the result would probably be fatal (inability to swallow).

Prevention.—Remove the causes:—

(a) Prevent mineral hunger by supplying adequate bone meal in the form of a lick; bone meal four parts, coarse salt one part; or

Di-calcic phosphate	45 parts.
Salt	40 parts.
Molasses	10 parts.
Water	5 parts.

(b) Top-dressing of pastures with superphosphate will eventually have the same effect as (a).

(c) Remove carcases and old bones from paddocks which are carrying stock and bury deeply, or preferably, burn them.

Cattle can now be immunized against this disease by means of an injection with a vaccine. Particulars may be obtained on application to this Department.

SCOURS IN CALVES.

This is usually due to errors in feeding, but may also be due to germ infection of feeding and drinking vessels, which should be kept scrupulously clean. All milk should be warmed before feeding to calves; if separated milk is given, fat should be added to it in the form of linseed meal and a little sugar. Medicinally give—

Powdered ginger, ½ ounce.
Sodium bicarbonate, 3 ounces.
Lime water, 16 ounces.

Dose—Two tablespoonsful three times a day in milk.

If not effective, give the following powder:—

Powdered catechu 2 ounces.
Powdered chalk, 2 ounces.
Sodium bicarbonate, 1 ounce.
Powdered ginger, ½ ounce.
Powdered opium, 1 ounce.

Dose—One tablespoonful twice a day.

WARTS.

These growths become most troublesome when situated on the teats.

Treatment.—This depends on their size and nature. Should they be small all that is required is the application of Castor Oil daily. If they are pendulous and rather large each should be tied at its base with a piece of cotton or silk thread. They will then drop off in the course of a few days. Large warts broadened out at the base should be treated by the application of a caustic stick. Silver nitrate is usually effective, but when applying, the surrounding skin should be smeared with vaseline.

COW POX.

This is an eruptive and contagious disease, and is characterised by an eruption on the udder and teats of vesicles or pustules. Small nodules appear firstly under the reddened skin of the udder. Small blisters or vesicles then form at the nodulated parts and are surrounded by a ring, red and congested. Later these vesicles become transformed into pustules containing matter and having a pearly appearance. These pustules eventually dry up and are succeeded by a brown scab which ultimately peels off, leaving a slight, depressed mark. This disease is spread by the hands of milkers, who are apt themselves to contract the disease.

Treatment.—Recovery is spontaneous, but may be assisted by thoroughly washing the teats after milking and applying twice daily to the affected parts a lotion composed of Hyposulphite of Soda, one half-ounce in 1 pint of water.

CONTAGIOUS ABORTION.

The disease is not new to this State, but when it occurs the income of the dairy farmer is materially reduced by a loss of milk, loss of calf, and time lost in treating affected animals. However, all such loss may be reduced to a minimum if the disease is understood by the farmer who, with successful treatment, prevents its progress, and the consequent sterility which commonly follows in the untreated animal. If sterility is avoided the disease is not to be feared, as second abortion is uncommon.

Abortion, by which is meant the birth of the calf at any stage of development prior to the natural period of gestation, may occur as the result of accidental incidence of external forces or may be due to contagion. I intend passing over the former, as any farmer who experiences abortion in his herd should in all cases act for safety and treat such cases of contagion as described below.

Contagious Abortion.—This may be defined as a disease of the womb resulting in the premature expulsion of the foetus. It is caused by a specific bacillus which gains access to the blood by the digestive tract, and which has a predilection for the pregnant womb and the udder of the non-pregnant cow. It sets up an inflammation therein, and the result is premature expulsion of the undeveloped calf at varying stages prior to normal gestation. The period when abortion most often occurs is between the 3rd and 7th month. The causal organisms of bacilli are always present in the "cleansings" and the discharges which come away with the imperfectly mature calf (or slink) and afterbirth. They are also found in the faeces of young calves from affected mothers. The disease, therefore, is spread by this means, resulting in contamination of the pastures, etc.

Symptoms.—When abortion is about to occur in a cow far gone in calf no symptoms sufficient to attract attention are, as a rule, exhibited. Occasionally evidence of uneasiness and attempts to apparently prepare for calving may be observed, but generally the event occurs with no premonition to the owner. However, after parturition the udder becomes swollen, there is relaxing of the tail muscles, and a discharge is noticed issuing from the vulva. Smearing of the buttocks and the tail with a discharge is a common observation.

Diagnosis.—Diagnosis of the disease is made certain by the Agglutination test which is carried out in a laboratory. Blood samples should be forwarded to the Stock Department for this purpose. This will detect cows of which the blood is affected with the bacillus of contagious abortion.

TREATMENT.

Vaccines.—Up to the present no preventive vaccine has been produced which is efficacious. Therefore the "cleaning up" of a herd should be carried out by methods as set out below:—

1. When a cow aborts isolate her immediately, and keep isolated for four weeks.
2. Search for the foetus (the aborted immature calf) and the afterbirth. These should be burnt thoroughly or buried deeply. When burying such material care should be taken when filling the hole to first throw in the soil removed from the ground surface.
3. Thoroughly dig up the ground afterwards together with an area of say three yards on every side and saturate the surface with a liberal supply of disinfectant.
4. The cow should be irrigated once daily for several days with the antiseptic solution perchloride of mercury (corrosive sublimate) 1 in 5,000; thence at weekly intervals if there be any discharge from the vagina. Tabloids for this purpose are specially made up, and may be procured at the druggists. Such tabloids should be thoroughly dissolved.
5. The bull should be treated by irrigating with perchloride of mercury, 1 in 5,000, although such animals have been proved of no potential danger unless reacting to the Agglutination test.

Method of procedure in treating cows.—For this purpose it is necessary to carry out irrigation with a 3ft. length of rubber tubing, one-half inch in diameter, and a small funnel which, if intended to be used with a perchloride of mercury

solution, must be either of glass or enamelled metal. Other utensils used should not be of metal owing to the corrosive action of this drug. Apart from the destruction of the container, chemical action takes place which renders the drug inert. For the treatment of the bull an ordinary enema syringe with vulcanite fittings should be obtained.

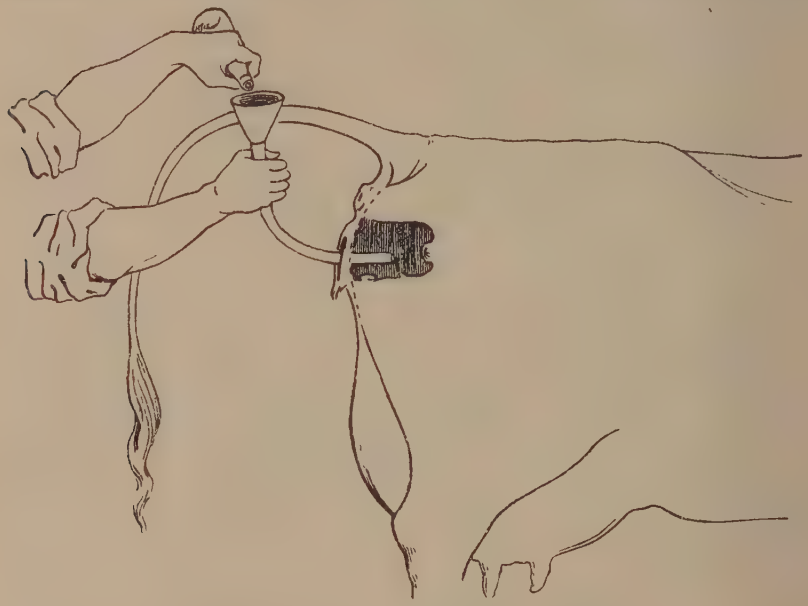
1. Boil for 5 minutes the tube and funnel, and then apply to the outside of the tube a dressing of salad oil, good lard or vaseline.
2. Wash the arms and hands thoroughly in hot water to which disinfectant has been added.
3. When irrigating the cow pass the free end of the tube by means of the hand gently into the womb, or, if the cow be sterile, as far as possible into the vagina without undue force being used.

Method of irrigating a cow which has aborted.

4. Hold the outer end of the tubing with the funnel inserted about six inches above the root of the cow's tail.
5. Pour the solution as described gently into the funnel and so thoroughly irrigate the parts. If the fluid does not flow freely from the tube the inner end need only be moved gently to and fro to secure a free flow.
6. Thoroughly wash down the parts from the root of the tail to the bottom of the udder, also inside of the tail, with some of the same solution as used for irrigation.
7. The bull should be placed in a crush pen or otherwise made secure. Grasp the prepuce (sheath) by one hand and pass the nozzle of the syringe inside the sheath, afterwards holding it in position with the same hand; with the other hand pump into the sheath a quantity of the solution to thoroughly irrigate the parts.

Disinfection of premises.—Stalls in which affected cows have been housed should be disinfected thoroughly with Izal Solution—1 in 20.

Sterility.—It is undeniable that careful and proper irrigation of the genital passages has generally resulted in the cow holding the bull after the first service. Sometimes however, the trouble has persisted in spite of treatment, but it has not infrequently been found that the treatment has not been carried out thoroughly.



Method of irrigating a cow which is sterile.

The failure of cows to conceive after contagious abortion may be determined as due to the following causes:—

(a) Metritis or inflammation of the uterus.
(b) Cervicitis or inflammation of the cervix.
(c) Acidity of the vagina.

The two former are undoubtedly due to neglect in treatment of the cow in the correct manner with antiseptics. The result is that a septic condition ensues. Such animals should be treated by irrigating with a solution of 1 in 2,500 of perchloride of mercury. In the latter case, where passage contents are acid, an alkaline wash is needed. The treatment necessary is to irrigate the passage just before service with a solution composed of 5 ounces of bicarbonate of soda (baking soda) in half a gallon of water. This has often proved successful and is specially recommended when no cases of contagious abortion are present in the herd and there is nothing to suggest that the contagion of this disease is responsible for the animal's failure to conceive.

Improper management of the bull is often the cause of cows failing to conceive. It is a bad practice to allow the bull to run at large with the herd. Such a practice has a tendency to overwork the bull, and he becomes stale. It is far better to provide a special enclosure for the bull, and bring the cows to him when ready, and remove them again when properly served. The number of cows served during the year at regular intervals should be from 50 to 60 for each mature bull, whilst young bulls should be used sparingly. Bulls should be well fed and kept in good condition—not overfat.

The improper use of perchloride of mercury should be avoided when irrigating the vagina. At least 48 hours should lapse between the time of irrigation and the time of service.

CHRONIC INFLAMMATION OF THE WOMB.

Chronic inflammation of the womb in dairy stock which have been bred from and subsequently become sterile is very frequent. The disease is often insidious in its onset, and no symptoms of derangement may be noticed in the affected animal until the cows fail to conceive after returning repeatedly to the bull.

Cause.—Inflammation of the womb in cows is caused by infection of the womb with micro-organisms. The most opportune time for infection to take place is at or immediately after calving time, as the womb is then open to external influences, and the introduction of infective material from outside the animal's body is an easy matter.

Symptoms.—As the inflammation present is very often of a mild catarrhal nature, no definite symptoms of the trouble will be detected unless a careful examination is made of the affected womb. The cow appears in normal health and condition, but fails to get in calf. On the other hand, when the infection of the womb is more virulent, there will be present a muco-purulent discharge, which is particularly noticeable during heat periods, when the mouth of the womb dilates slightly. In some cases there is constantly present even in between heat periods, a discharge of pus from the inflamed womb. This discharge is often so great as to soil the tail and buttocks of affected cows. When the discharge is great a general appearance of unthriftiness in addition to sterility ensues.

Course of the disease.—The disease of the womb following inflammation will at times disappear spontaneously, and the animal returns to normal condition to conceive at a subsequent heat, but in a great number of cases the inflammation spreads from the body of the womb to involve in turn the fallopian tubes and ovaries. In consequence the fallopian tubes become blocked and the ovum generated in the ovary is prevented from reaching the site of fertilisation. When the infection reaches the ovaries these undergo degeneration, and numerous cysts form in the substance on the surface of the ovaries. When the fallopian tubes and ovaries become involved the prospects of getting the cow in calf are not bright and the treatment necessary in those cases becomes prolonged and technical.

Prevention of inflammation of the womb.—It is in the matter of prevention of this condition that the stock owner has an important role to play, because in preventing the onset of the affection he is also preventing the appearance of a state of infertility amongst his dairy stock. Inflammation of the womb in a great number of instances may be traced to neglect of ordinary hygienic principles in regard to treatment of in-calf dairy stock. The following points should be observed by all whose attention is directed towards the management of the dairy herd:—

(1) Cows housed or paddocked immediately prior to calving should be placed in the most hygienic surroundings possible. If housed the shed should be properly cleaned before the cow about to calve is allowed in. It is advisable to spray the walls, floor, and fittings with a disinfectant solution—1 part lysol to 160 parts of water will make a reliable disinfectant solution for this purpose. A clean bed should be provided for the cow; hay or straw will serve this purpose provided that it is clean. If the bedding used is dusty it is advisable to allay the dust by sprinkling lightly with the disinfectant solution as used on the shed structure. Cows should not be allowed to calve down in paddocks which are covered with the droppings of other cows, as the infection from manure may be carried by flies and

deposited on the genital organs of the newly calved cow. During the summer months, when the manure becomes dried and pulverised, the wind will act as an agent to spread the contamination from the dirty ground surfaces of the paddocks on to the tail and back passages of cows allowed to lie in such surroundings. These precautions are especially necessary during the first three days after calving, as then the womb is partially open and infection is likely to gain entrance and set up inflammation.

(2) In the event of it being necessary to render assistance to cows at calving time the person undertaking the task should use every care as regards his hands, arms, and any instruments or appliances required. Finger nails should be clipped short and cleaned, hands and arms washed thoroughly in a disinfectant solution—lysol 1 to 160 in water, *i.e.*, lysol one teaspoonful to every pint of water required. Any instruments or ropes required should be sterilised by boiling for 15 minutes prior to use and kept, till required for use, immersed in a disinfectant solution. The tail and back parts of the cow should be washed down with soap and water and sprayed with a disinfectant solution before proceeding to introduce the hand into the genital passage. Care should also be observed that manure passed by the animal in straining during the operation is not introduced with the arm—this may be obviated by an assistant ready to wash and disinfect the arm of the operator should contamination occur.

(3) *Retention of the afterbirth.*—This is frequent among animals that calve prematurely and is also met with frequently in cows which calve after the normal period of gestation. The membranes do not separate completely from the inside surface of the womb, and the muscular walls of the womb fail to contract and produce separation and expulsion as should occur normally. When the afterbirth in the cow is not expelled within the first 24 hours after calving, measures should be taken to effect and assist its removal. It is not a good policy to tear out the retained membranes forcibly, as in this process the womb is likely to be wounded and infection of the wounds is very probable. If the retained afterbirth is not removed with moderate traction, a better policy is to fill up the womb with disinfectant solution by means of a proper syringe. A suitable disinfectant for this purpose is corrosive sublimate, 1 in 5,000 parts of water. The solution should be used at blood heat, an amount of one gallon being used for each douche. Should the animal strain and expel the fluid introduced whilst the operation is proceeding this is to be allowed, and when the expulsion of the fluid has ceased for the time being the douching may be proceeded with. In this way infection of the womb from decomposing afterbirth will to a great extent be prevented, and at the same time the effect of the fluid in the womb induces it to contract and expel the retained afterbirth. Douching should be carried out three times daily till the membranes come away and afterwards twice daily till all discharge has ceased. Care must be exercised with the syringe used; it is advisable to boil it for ten minutes before using each time. Isolation of a cow with retained membranes is advisable, as the discharges from the womb are certain to be septic to a great extent, and it is possible to have infection spread from this source to other animals in the herd which are susceptible.

(4) Care and perseverance should be adopted in the treatment of all cases of a suppurative character which may occur amongst cows in a herd. Wounds which become septic should be treated antiseptically until healing takes place. If the discharge from septic wounds is great, in addition to treatment the animal affected should be isolated. This precaution is also necessary in cases of inflammation of the udder where there is an abscess formation in the udder tissue and the pus formed comes away through the teat duct on stripping and through the udder wall when the abscess bursts externally.

SHEEP.

FATTY INFILTRATION OF LIVER IN EWES.

This is a very fatal disease of the liver in ewes, usually occurring from a fortnight to within a few days before lambing. The affected ewes show a disinclination to move about, and may have a yellow (jaundiced) tint of the skin and the eyelids, due to the liver being unable to get ride of its bile, which is reabsorbed into the general circulation. After a few days the ewes go down, and refuse, or appear unable, to rise, and gradually waste away until they die. *Post mortem* examination reveals a fatty, yellow liver.

Treatment.—Avoid overfeeding before lambing. Give laxatives and exercise.

OPHTHALMIA OR "PINK EYE."

This disease is caused by a germ infection of the outer covering of the eyeball, and is seasonal in its occurrence. It appears generally during the summer months, and is mostly associated with travelling sheep. The movement of sheep from one place to another facilitates its spread owing to its infectious character. When occurring on farms it causes a loss of condition in sheep, but apart from that no other economic loss eventuates. The causal germ is carried from one sheep to another by means of flies, etc.

Symptoms.—The affected sheep will be firstly noticed in their inability to follow the mob. When being driven singly the head is held erect as if the animal is endeavouring to hear in order to discover its direction. When standing quietly the head is held low in order to avoid light. In the early stages of this disease the eye or eyes are noticed discharging water freely. On examination the eye will appear deeply injected or "bloodshot." From this the name is derived—"pink eye." The eye will be noticed free from foreign bodies, such as grass seeds, etc. The eye gradually becomes worse and the lids become gummy. The eyeball itself becomes opaque at a later stage. It even loses its oval shape and becomes pointed in front. It is at this stage that the animal begins to lose condition, and if affected in both eyes even runs into obstacles or waterholes and becomes drowned. The disease gradually spreads to all sheep in close contact, but usually only one eye is affected.

If proper treatment is provided the sheep will gradually recover their eyesight, and spread of the disease to other sheep will be prevented. In this connection it might be as well to remind sheep-owners that it is an offence under the Stock Diseases Act to sell sheep affected with any infectious disease. The only way to avoid "Pink Eye" is to—

(1) refuse to purchase sheep from known infected flocks;

(2) examine fresh purchases and isolate them for a week, or until satisfied that they are free from disease. This is a wise procedure with all fresh purchases of live stock. If the flock is already infected remove the infected sheep into a well-shaded homestead paddock, and hand-feed and water to prevent the serious loss of condition which will otherwise occur. The eyes of these sheep should be treated daily with the following lotion:—

Sulphate of zinc—90 grains.
Water which has been boiled and allowed to cool—1 pint.

All discharges from the eyes should be removed with cotton wool, before using the eye lotion. The lotion must not be made up overstrength or permanent damage may be caused to the eye. If unable to get the lotion made up, the following

lotion may be used instead:—Boracic acid, one teaspoonful, dissolve in a little hot water in a cup. Get a clean beer bottle which has previously been rinsed out with hot water, and fill to neck with warm water which has been previously boiled, then add boracic acid solution. Shake before using. Sheep which are showing an opacity or whiteness of the cornea may be treated with the following lotion:—

Silver nitrate—1 drachm.
Water which has been boiled—1 pint.

A camel hair brush or a fountain pen filler are useful to apply the lotion, or a clean new oilcan.

Every morning early the healthy sheep should be inspected to pick out the fresh cases, and these should be removed to the isolation paddock. As the sheep recover they should be put into another paddock, and not allowed to mix with the healthy sheep until all danger of infection has ceased. The sheep usually recover their sight fully and the infection will disappear in time, but the loss of condition is nearly always severe, and the amount of extra work involved in handling the flock or moving them about is often enormous.

An experiment carried out recently at the Veterinary Laboratory proved that this disease is infectious. Work is also being carried out to find out the causal organism and, if possible, to produce a vaccine which will prevent infection.

BOX POISONING IN SHEEP.

This is prevalent in the Great Southern districts of the State. The box plant is very difficult to eradicate permanently, and the seedlings appear after rains in paddocks which have been burnt, even twenty years after the poison has been erroneously thought to be eradicated. The seeds of this plant are also poisonous. Sheep eating the seedlings show brain symptoms in a few hours. They run around in circles, soon develop convulsions, and die. On *post mortem* examination the heart is found to be distended with blood, and the lungs, liver, and kidneys are congested.

Treatment.—Give potassium permanganate or antidote tablets when possible. When administering potassium permanganate give as much as will lie on a sixpenny piece. Do not drove affected sheep

FOOT ROT IN SHEEP.

There are two kinds of Foot Rot, viz.:—(1) Traumatic; (2) Infectious. Traumatic foot rot is due to injuries to the feet by various external objects, *i.e.*, Doublegees, etc. Infectious foot rot is an infection of the foot of the sheep with a specific germ.

The second form is the more serious, although both prevent sheep travelling to obtain food, and thus cause loss of condition. The second form is very rare, but occurs on moist rich ground in certain localities which appear to harbour the germ.

Symptoms of Traumatic Foot Rot.—When first attacked the sheep shows slight lameness, and on examination of the feet there is a swelling around the coronet where the hair joins the hoof, the hoofs are inflamed and hot and later the pain becomes intense and the sheep grazes on its knees. In advanced cases the hoof may slough off.

Treatment.—Keep the sheep off damp flats in winter. Run affected sheep through a gateway with lime on the ground. All foreign bodies should be removed from the hoofs, and where necessary surgical treatment applied.

A trough 12 feet long, one foot wide, and six inches deep should be placed in the drafting race, and the following mixture made and poured into the trough to a depth of three inches:—

Alum, 4 ounces.
Sulphate of copper, 4 ounces.
Warm water, 5 quarts.

The affected sheep should be walked through this night and morning. Afterwards dress with sulphate of copper and Stockholm tar—equal parts. Another mixture is made from perchloride of mercury and Stockholm tar, one in four, blended with castor oil. Still another can be made from arsenic, 2 lbs., and potash, 2 lbs., boiled in one gallon of water over a slow fire for half an hour. Keep stirring and when the mixture is likely to boil over add 8 gallons of cold water.

Sheep should never be brought from a farm where Foot Rot is known to exist.

CARRION POISONING (BOTULISM).

This disease is due to the ingestion by sheep of rabbit carcases which have become infected with a germ known as bacillus botulinus. The carcase-eating habit is developed in sheep owing to continued feeding during the long dry summer on stubble and other pastures which are deficient in phosphates. It will not become evident in the winter months but usually in the middle or end of the summer.

Symptoms.—Sheep mostly affected are young sheep and in good condition. In some cases the initial symptoms appear to be wriggling of the tail as though flyblown. Later they show a stiff gait and a disinclination to move, progressing only for a short distance and then lying down. The animal appears dull and does not attempt to eat. When standing, the head is held in a drooped position frequently with the lower jaw hanging down. From the open mouth a more or less profuse flow of saliva occurs. In advanced cases respiration is spasmodic and abdominal. Finally the animal is unable to rise and dies quietly without a struggle. The mortality is usually in the vicinity of 10 per cent.

Prevention.—Cure by treatment is not known, but preventive measures should be adopted. A lick should be provided composed of equal parts of bonemeal and coarse salt or a mixture composed of:—

Di-calcic phosphate	45 parts.
Salt	40 „
Molasses	10 „
Water	5 „

The rabbit carcases should be collected and burnt.

Recent experimental work indicates that sheep can be immunized against the disease by means of an injection of toxoid. Particulars may be obtained on application to this Department.

STOMACH WORMS (PARASITIS GASTRITIS).

It has been demonstrated that "breed and feed" are necessary to produce a fat lamb, but this must be added: "and freedom from disease."

The disease referred to is the not uncommon one which inhibits the fattening propensities of sheep, and especially lambs. This most important disease is parasitic gastritis, caused by worm infestation of the fourth stomach. It is usually slow in its incidence, and for that reason is not usually detected by sheep owners until gross infestation occurs. The parasites or worms responsible, therefore, often affect sheep without causing mortality, and their presence in the alimentary tract

is significant only in the obstinacy of sheep or lambs to fatten when depasturing under ideal feed conditions. In such circumstances the owner invariably attributes the cause to incorrect breeding or feeding. The latter is blamed mostly, and in doing so the owner is apt to condemn not only his own pastures but the pastures generally in the district. Subterranean clover is often considered responsible in this respect. It is responsible only by virtue of its luxuriant and matted growth, and its capacity to retain moisture. This type of pasture is a most suitable media for the propagation of parasites, so that Subterranean Clover, as well as other luxuriant growing and matted pastures, can only be blamed indirectly, as the parasites are the direct cause. Get rid of the parasites, and the food supply becomes all that is desired. Care should be taken if lambs do not fatten readily on pastures, which are beyond doubt as to their feeding qualities, that the possibility of the presence of stomach worms is firstly eliminated. Ewes or mature sheep may harbour parasites in their digestive tract without being noticeably affected. It is well known that mature sheep are not so susceptible to the ravages of parasites as young and growing sheep. This may be explained in the following manner:—The mature sheep has to produce wool and maintain flesh, fat, bone and other tissues, whilst the lamb has not only to do all these things but has, in addition, to produce growth. The result is that the interference of the absorption of nourishment which takes place in the attack of the stomach wall by parasites reflects on the condition of the growing lamb more so than on the mature sheep.

The Parasite.—This is a round worm of the nematode kind, and known as *Haemonchus contortus*. To the naked eye, it is one-third to one-half inch in length, and in diameter resembles a silk thread. If one looks closely into the stomach contents or examines the stomach wall after the contents have been tipped out, the worm is easily seen. The eye is attracted firstly to it on account of its movement, and they may even be seen coiled in clumps. The portion of the stomach in which these parasites are found is known as the abomusam or fourth stomach. This stomach is easily found by locating firstly the well-known stomach—the "bible." The fourth stomach follows on immediately after this. Its surface is rather white and smooth, and has folds at intervals.

Life History.—The worms are taken into the stomach usually in their embryonic stage by ingestion with pastures or water. On reaching the fourth stomach these parasites attach themselves to the mucous membrane, where they mature and obtain their nourishment by blood-sucking. Here they lay their eggs, which are eventually deposited on to the pasures or into stagnant water, and so the life cycle continues. It is important to note that when taken up into the stomach the mature worms continue to develop for a period of from two to three weeks, after which the adult sexually mature worms are developed, and the next generation of worms is started. Thus in a period of six weeks the third generation of worms comes to life. These parasites like moisture, and are in consequence more dangerous when matted and succulent pasture exists, or when sheep have access to and so pollute open dams or stagnant water.

Symptoms.—Sheep which are not grossly infected with these worms show no marked symptoms of the trouble, except the difficulty experienced in fattening. When infestation is heavy they rapidly lose condition with progressive weakness and anaemia. Fluid-like swellings may occur on the lower jaw, with the result that a "bottle-jaw" appearance is noticed. This is particularly common in lambs, and at this stage they are apt to die from weakness and exhaustion. Loss of wool is sometimes seen in the later stages of this disease.

Preventive Measures.—Paddocks should be well drained, and the sheep should be placed on high ground during the winter months, and not allowed to graze on low-lying and swampy land. The water supply should consist of running

water or wells. Dams or stagnant water should be avoided unless fenced off, and the sheep watered from them by means of a trough. Water supplies to which sheep have access become contaminated with faeces, and in this manner the parasites are distributed. In serious outbreaks in sheep the animals should be removed from the affected pastures or waterholes so as to prevent further infestation. As already stated, mature sheep often harbour the parasites without showing any marked symptoms, and for that reason lambs should not be depastured with ewes after weaning.

Treatment.—When the disease makes its appearance drenching should be adopted. The most efficient vermifuge is a solution of Copper Sulphate combined with mustard. This should be made up as follows:—Take ¼ lb. of Copper Sulphate crystals (Bluestone), and dissolve thoroughly in 1 pint of boiling water. Take also ¼ lb. mustard, and mix with sufficient water until the mixture is thoroughly fluid; then mix the Copper Sulphate solution and the mustard mixture together, and add sufficient water to make up to 3 gallons. Earthenware or glass vessels should be used for preparing and containing the mixture. The sheep should be drenched in a standing position after being starved for 12 hours.

Dose—

Sheep over 12 months, 2 to 3 ounces.
Lambs, 9 to 12 months, 1½ ounces.
Lambs, 3 to 6 months, ½ ounce.

The drenching should be done monthly if the sheep are badly affected. In addition, sheep which are weakened through the effects of these parasites should be allowed a liberal supply of concentrated food, such as oats, whole or crushed.

RHEUMATISM.

This is an inflammation of the fibrous structures of the joints, tendons, ligaments, accompanied by fever, stiffness and lameness. There are two forms:—

(1) Acute Rheumatism or Rheumatic Fever.
(2) Chronic Rheumatism.

Acute rheumatism sometimes leads to chronic rheumatism if not treated, but is often followed by complete recovery if treated early. Chronic rheumatism is liable to become acute at intervals. It is more persistent, and leads to alterations of structure in the white fibrous structures and bones, especially the joints. Vegetations sometimes occur in the valves of the heart and permanent changes occur in the heart muscle.

Symptoms.—Acute Rheumatism; Sudden lameness with a swelling of joints or tendons. Lameness may disappear from one part and show up in another. The pulse is hard and unyielding, and mouth hot and dry. Constipation is usually present. Swellings gradually harden, but seldom suppurate. Temperature is usually high—105deg. F. to 106deg. F.

Chronic rheumatism is similar to the above, except that the fever may be absent.

Articular (joint) rheumatism is common in milking cows.

Muscular rheumatism affects horses and dogs chiefly.

Treatment.—Keep animals warm.

Acute Rheumatism (Horse).—Give an Alotic ball 6 to 8 drachms, according to size of the animal. One tablespoonful of nitrate of potash (saltpetre) should be given in the drinking water daily. An ounce capsule of salicylate of soda should be given night and morning until temperature returns to normal.

Local Treatment.—If pain is very great, foment and apply liniment of belladonna, made up from—

Solution belladonna, 6 ounces.
Spirits of camphor, 10 ounces.
Acetic acid, ½ ounce.
Soft soap solution to 26 ounces.

Chronic Rheumatism.—Blister near the affected parts and repeat if necessary. Blisters are very beneficial in all cases. Scalding water or cautery may be used.

Pigs.—These animals are very susceptible to rheumatism, and should be provided with warm and dry beds. If they become affected they should be given a purgative: Calomel, 1 drachm, and Salicylate of Soda, 1 teaspoonful, in the feed.

NASAL BOT.

This is a grub almost similar to the stomach bot which infests horses. It is known as Oestris ovis and is the product of a fly which deposits its eggs ready to hatch or larvae on the nostrils of sheep. The larvae then crawl up the nasal chambers and accommodate themselves in the head cavities and horn cores. These maggots remain in the sinuses until they are ready to pupate, when they are sneezed on to the ground, where, in six or eight weeks after pupation, they develop into the fly.

Symptoms.—Sneezing, discharge from the nose and staggering gait are the symptoms suggestive of the presence of the larvae in the nostrils.

Treatment.—Remedial treatment is not successful. Seldom any harm results from these grubs other than loss of condition. Preventive measures may be adopted by preventing the fly from striking the sheep's nose. This may be done by providing a salt lick for the sheep in a V-shaped trough of which the sides are smeared with Stockholm tar. Thus the sheep will smear their noses with tar, which will act as a fly repellent.

GRASSHOPPER PEST.

Poison Bait Formula.

L. J. NEWMAN,
Entomologist, Department of Agriculture.

Bran, 25 lbs.; Powder Arsenite of Soda (80 per cent. arsenious oxide), ½ lb.; Molasses, 6 lb.; Water, 2½ gallons.

The molasses and poison are dissolved in the water and then mixed with the bran until a moist, crumbling mash is formed. If the mash is made too wet it will go lumpy, which should be avoided as any lumps distributed remain a potential danger to stock and other animals just as long as the lumps remain.

The bait should be distributed among the hoppers on a bright, still, fine morning.

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